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Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

Ottawa, Ont. K1A 0H3
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# STATUS REPORT ON THE PEARY CARIBOU
# RANGIFER TARANDUS PEARYI

## IN CANADA

BY

FRANK L. MILLER

STATUS ASSIGNED IN 1991
BANKS ISLAND POPULATION - ENDANGERED
HIGH ARCTIC POPULATION - ENDANGERED
LOW ARCTIC POPULATION - THREATENED

REASON: BANKS ISLAND POPULATION - CONTINUING POPULATION DECLINE TO CRITICAL LEVELS. HIGH ARCTIC POPULATION - CONTINUING POPULATION DECLINE TO CRITICAL LEVELS. LOW ARCTIC ISLANDS POPULATION - HIGH WINTER MORTALITY, LOW REPRODUCTION AND MINIMAL RECRUITMENT. ADDITIONAL PRESSURE COMES FROM HUNTING AND DISTURBANCES ASSOCIATED WITH INDUSTRIAL ACIVITIES.

OCCURRENCE: NORTHWEST TERRITORIES (ALL POPULATIONS)

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Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

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FRANK L. MILLER
WESTERN AND NORTHERN REGION
CANADIAN WILDLIFE SERVICE
ENVIRONMENT CANADA
EDMONTON, ALBERTA

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## A. Abstract

Peary caribou (Rangifer tanandus pearyi) populations on the Queen Elizabeth Islands of the Canadian High Arctic have sufferred a continual overall drastic decline of about 90% in the past three decades. Their island-populations are now mere remnants of their former sizes and their future survival is endangered and in doubt. The plight of the Peary caribou on the Queen Elizabeth Islands should be recognized and those caribou should be reclassified as an "Endangered" form of wildlife in Canada. This would be a beneficial first step in advancing the conservation and preservation of the Peary caribou.

The most biologically sound and necessary approach for the proper conservation of Peary caribou involves first the recognition of those populations of R. t. pearyi on the Queen Elizabeth Islands as genetically and possibly ecologically distinct from all other forms of Rangifer, including those forms of "arctic-island" caribou (R. t. groenlandicus x pearyi) on the southern tier of Arctic Islands. Polyacrylamide gel electrophoresis analyses of transferrin variation indicates that both kinds and frequencies of alleles present are significantly different between Peary caribou from the Queen Elizabeth Islands and "arctic-island" caribou from the southern tier of Arctic Islands (south of ca. 74°N).

Ancestral Peary caribou (R. t. pearyi) that originally occupied the southern tier of Arctic Islands were altered over

time with genetic material from invading barren-ground caribou (R. t. groenlandicus) from the mainland and the caribou populations now found on those islands no longer represent the purest line of pearyi. All current and recent analyses of transferrin alleles (and also the precursory studies using morphometrical measurements, when examined in detail) substantiate the distinction between the pearyi line of Peary caribou on the Queen Elizabeth Islands and the transitional forms of "arctic-island" caribou (groenlandicus x pearyi) from the southern tier of Arctic Islands. Also, there is no evidence that barren-ground caribou from the mainland or even "arctic-island" caribou from the southern tier of Arctic Islands ever invaded and successfully established themselves on any of the Queen Elizabeth Islands. Therefore, it appears most likely that there are important stringent environmental differences between High Arctic range and more southerly ranges, including the southern tier of Arctic Islands, that demand first the evolution of physiological and morphological characteristics now possessed only by the purest line of pearyi in order to survive in the Canadian High Arctic over time.

Thus, the pearyi line on the Queen Elizabeth Islands is both genetically and ecologically diversified from the groenlandicus x pearyi forms now found on the southern tier of the Arctic Islands and cannot be considered interchangeable or the same in terms of their conservation or preservation. This

distinction has particularly strong management implications as regards the feasibility of translocations of transitional forms of "arctic-island" caribou from the southern tier of Arctic Islands to the Queen Elizabeth Islands in the event of total die-offs. The existing evidence argues that such an option would not be biologically sound or viable.

The Peary caribou is the only member of the deer family Cervidae and the only form of Rangifer found in the Canadian High Arctic. The passing of Peary caribou from the terrestrial ecosystem of the Canadian High Arctic would represent a significant tragic loss of highly evolved genetic material and it would create both significant ecological and sociological voids in the natural heritage of the Canadian Arctic.

Rangifer tarandus pearyi is a uniquely Canadian subspecies now found regularly only on the Canadian Arctic Archipelago and nowhere else in the world. The total present number (3300-3600) of Peary caribou is a mere remnant of their former strength and their precarious existence in one of the harshest environments in the world is under potential pressure from anthropogenic climate change, hunting, disturbances from nonrenewable resource developments, and man-caused contamination of arctic ecosystems. Thus, because of their perilous state and the potential for man's actions further detrimentally impacting on them, Peary caribou on the Queen Elizabeth Islands should be classified as "Endangered".

The trend in population estimates for "arctic-island" caribou on Banks Island has been one of decline since the early 1970s to only about 8% of the former size. As the currently estimated size of the caribou population will not sustain even the current (1989) reported level of harvest let alone higher past rates of harvest, the population of "arctic-island" caribou on Banks Island should also be classified as "Endangered".

The single population estimate for caribou on Victoria Island in 1980 must be a gross underestimate of the subsequent size of the population, if the reported annual harvests in the 1980s are accurate. It would require about three times as many caribou as estimated on Victoria Island in 1980 to sustain the population under subsequently reported rates of annual harvest. Otherwise, the potential for rapid decline of the "arctic-island" caribou on Victoria Island is real, especially if compounded by high mortality or failures of calf crops due to other environmental factors. The information available for "arctic-island" caribou in the Prince of Wales Island-Somerset Island-Boothia Peninsula complex is inadequate to ascertain their current numerical status. If, however, the population size has declined or the annual harvests have increased greatly, the potential is for future population decline on that island-peninsula complex. Thus, those populations of "arctic-island" caribou on Victoria Island and the Prince of Wales Island-Somerset Island-Boothia Peninsula

complex should be classified as "Threatened" until their vulnerability to increased hunting pressures and human actions are assessed or the population obviously fails.

Caribou on King William, Royal Geographical Society, Matty, and Jenny Lind islands are currently too few to be meaningfully evaluated separately and they should be grouped with the other "arctic-island" caribou recommended for the "Threatened" status.

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## A. Résumé

Les populations de caribous de Peary (Rangifer tarandus pearyi) des îles de la Reine-Élisabeth, dans le Grand Nord canadien, ont diminué dans des proportions catastrophiques au cours des trois dernières décennies, leur nombre ayant chuté d'environ 90%. Les populations insulaires ne sont plus maintenant qu'un vestige des troupeaux d'antan, et leur survie est précaire et menacée. La situation critique des caribous de Peary des îles de la Reine-Élisabeth devrait être reconnue et ces caribous devraient être reclassés comme une espèce "menacée de disparition" au Canada. Cette action constituerait une première étape favorable en vue d'aider à la protection et à la conservation des caribous de Peary.

L'approche la plus sensée et la plus essentielle au point de vue biologique pour la conservation adéquate des caribous de Peary implique tout d'abord que les populations de R. t. pearyi des îles de la Reine-Élisabeth soient reconnues comme étant génétiquement et peut-être écologiquement distinctes de toute autre forme de Rangifer, y compris les espéces de caribou "des îles arctiques" (R. t. groenlandicus x pearyi) qui se trouvent dans la partie sud de l'archipel arctique. Des analyses avec électrophorèse en gel de polyacrylamide des variations de transferrine ont indiqué que les alléles du caribou de Peary des îles de la Reine-Élisabeth et ceux du caribou "des îles arctiques" de la partie dus de l'archipel arctique (sud du 74°parallèle nord) présentent des différences

importantes en ce qui a trait à leur nature et à leur fréquence.

L'ancêtre du caribou de Peary (R. t. pearyi) qui occupait auparavant la partie sud de l'archipel arctique a fini par être contaminé par du matériel génétique provenant du caribou de la toundra (R. t. groenlandicus) qui avait envahi son territoire à partir du continent. Ainsi, les populations de caribous qu'on trouve maintenant sur ces îles ne représentent plus la lignée la plus pure de pearyi. Toutes les analyses courantes et récentes des allèles de transferrine (de même que les études préliminaires effectuées à l'aide de mesures morphométrique lorsqu'on les examine en détail) justifient la distinction établie entre la lignée pearyi du caribou de Peary des îles de la Reine-Élisabeth et les formes transitoires du caribou "des îles arctiques" (groenlandicus x pearyi) de la partie sud de l'archipel arctique. De plus, rien n'indique que le caribou de la toundra du continent on même le caribou "des îles arctiques" de la partie sud de l;archipel arctique ait un jour envahi l'une des îles de la Reine-Élisabeth et qu'il ait réussi à s'y établir. Par conséquent, il semble très probable qu'il y ait d'importantes différences environnementales entre les habitats du Grand Nord et les habitats plus au sud, y compris la partie sud de l'archipel arctique. Ces différences ont d'abord exigé l'évolution des caractéristiques physiologiques et morphologiques que possède maintenant la seule lignée la plus pure des pearyi afin

qu'elle puisse survivre dans le Grand Nord canadien au fil des temps.

Ainsi, la lignée pearyi des îles de la Reine-Élisabeth diffère, tant génétiquement qu'écologiquement des formes groenlandicus x pearyi qu'on trouve maintenant dans la partie sud de l'archipel arctique, et on ne peut les considérer comme étant équivalentes ou interchangeables en matière de conservation et de protection. Cette distinction a des répercussions particulièrement importantes au niveau de la gestion en ce qui concerne la possibilité de déplacer, de la partie sud de l'archipel arctique aux îles de la Reine-Élisabeth, les formes transitoires du caribou "des îles arctiques" en cas de disparition rapide et totale. D'après les renseignements que nous possèdons, cette option ne serait pas valable ou viable sur le plan biologique.

Le caribou de Peary est le seul membre de la famille des cerfs (Cervidae) et la seule espèce de Rangifer qu'on rencontre dans le Grand Nord canadien. La disparition du caribou de Peary de l'écosystème terrestre du Grand Nord canadien représenterait une perte tragique importante de matériel génétique hautement évolué, et elle créerait un important vide écologique et sociologique dans le patrimoine naturel de l'Arctique canadien.

Le Rangifer tarandus pearyi est une sous-espèce uniquement canadienne qu'on rencontre aujourd'hui seulement dans l'archipel arctique canadien et nulle part ailleurs dans

le monde. Le nombre total actuel de caribous de Peary (de 3 300 à 3 600) n'est qu'un vestige des anciennes populations, et leur existence précaire dans l'une des régions les plus inhospitalières du monde est en outre menacée par les changements climatiques d'origine anthropogène, la chasse, les perturbations causées par l'exploitation de ressources non renouvelables et la contamination des écosystèmes de l'Arctique du fait de l'activité humaine. Ainsi, en raison de leur situation précaire et de la possibilité d'une plus grande ingérence humaine nuisible, les caribous de Peary des îles de la Reine-Élisabeth devraient être considérés comme une espèce "menacée de disparition".

La tendance dans les évaluations de la population de caribous groenlandicus x pearyi, de l'île Banks, est à la baisse depuis le début des années 70 et il ne reste aujourd'hui au'environ 8% de la populaion d'antan. Puisque la population de caribous, en raison de sa taille actuelle (d'après les estimations), ne survivra pas au nombre d'animaux abattus actuellement (1989) par les chasseurs (récolte), sans compter le nombre d'animaux abattus antérieurement qui était encore plus élevé, la population de caribous groenlandicus x pearyi, de l'île Banks, devrait également être considérée comme étant "menacée de disparition".

Si les chiffres des récoltes annuelles qui ont été rapportés chaques année au cours des années 80 sont précis, l'unique évaluation de la population des caribous de l'île

Victoria, effectuée en 1980, doit être une grossière sous-estimation de la taille subséquente de la population. Il aurait fallu que la population de caribous soit environ trois fois plus élevée que celle dénombrée sur l'île Victoria en 1980 pour pouvoir survivre aux taux de récoltes annuelles qui ont été rapportés par la suite. Autrement, le risque de disparition rapide du caribou groenlandicus x pearyi de l'île Victoria est réel surtout si on y ajoute le taux élevé de mortalité ou la mort des veaux nouveau-nés, qui sont causés par d'autres facteurs. Les renseignements disponibles sur le caribou groenlandicus x pearyi de la zone de l'île du Prince-de-Galles, de l'île Somerset et de la péninsule de Boothia ne permettent pas d'établir leur nombre de façon certaine. Cependant si la taille de la population a diminué ou si les récoltes annuelles ont de beaucoup augmenté, un déclin futur de la population risque de se produire dans cette zone. Ainsi, les populations de caribous groenlandicus x pearyi de l'île Victoria et de la zone de l'île du Prince-de-Galles, de l'île Somerset et de la péninsule de Boothia devraient être considérées comme "menacées" jusqu'à l'ingérence humaine soit effectuée ou que la population diminue de façon évidente.

Il y a actuellement trop peu de caribous sur les îles de Roi-Guillaume, de la Royal Geographical Society, Matty, et Jenny Lind pour en faire une évaluation distincte significative. On devrait donc regrouper ces populations avec celles du caribou des "îles arctiques" qui, d'après les

recommendations, devraient obtenir le statut de "menacés".

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## B. Distribution

### B1. World-Wide

Peary caribou (Rangifer tarandus pearyi) with the most pronounced, genetically-based pearyi characteristics apparently now occur regularly only on the Queen Elizabeth Islands of the Canadian High Arctic (Fig. 1). Other "arctic-island" caribou, (R. t. groenlandicus x pearyi) that are commonly but mistakenly referred to as "Peary" caribou occur on the southern tier of islands (south of 74°N) in the Canadian Arctic Archipelago and on the Boothia Peninsula (north of 70°N) north of its isthmus (Fig. 2). Some of those transitional forms are phenotypically Peary-like in size and appearance (R. t. pearyi > groenlandicus), while others (R. t. groenlandicus > pearyi) are transitional in size and appearance between pearyi and the Canadian mainland barren-ground form (R. t. groenlandicus). To date, the phenotypic variation in these forms of Rangifer is best illustrated by coloured photographs in Jakimchuk and Carruthers (1980: Plates 1 and 2).

Currently, there are no viable populations of Peary caribou known on Greenland (Meldgaard 1986). Roby et al. (1984) refuted Banfield's (1961) proposal that caribou on coastal northwestern Greenland (the Inglefield Bay population) were intergrades of pearyi and groenlandicus. Roby et al. (1984) indicated that the Inglefield Bay caribou were actually an "environmentally stunted" form of groenlandicus. Meldgaard

(1986) reported, however, that pearyi-sized caribou have occurred in northern Greenland at various periods during the past several thousand years but that current occupation apparently has been reduced to a few migrant Peary caribou from the Canadian Arctic Archipelago, most likely from Ellesmere Island. Until 1991, the last apparent migrant Peary caribou to be killed and reported by Greenland hunters was in 1978 (Roby et al. 1984). In 1991, however, it was estimated that during the 1980s, hunters usually took 1-5 (and no more than 10) caribou annually in Inglefield Land, based on interviews with Greenland hunters by A. Rosing-Asvid, a biology graduate student (M.A.D. Ferguson, pers. commun., 1991). Then, between May and November 1990, hunters in Inglefield Land supposedly killed from 100 to 140 caribou, based on information from A. Rosing-Asvid (M.A.D. Ferguson, pers. commun., 1991). Subsequently, the following information was provided by Peter Nielson of the Greenland Home Rule Government (M.A.D. Ferguson, pers. commun., 1991). "A geologist 'travelled by helicopter over large parts of Inglefield Land' during the month of August 1991. 'They only saw 8 (living) caribou...' The pilot said 'that it was the small caribou from Canada, where he has seen them before.' The geologist saw an unknown number of 'caribou hides, heads and antlers in three (Inuit) summer camps.' In conversation with local people through his Inuit wife, the geologist was informed 'that some caribou arrive... every year' (from

Canada). To the question: how many, 'they had answered 30-40...' They often had seen footprints from caribou crossing from Ellesmere Island to Ingefield Land."

Banfield (1961) suggested that the evolutionary line of pearyi split from the groenlandicus line of Rangifer as early as 120 000 BP. Others suggest, however, that high arctic caribou evolved from a common ancestral population before the late Wisconsinan-Weichselian glaciation, possibly as early as 225 000 years BP (Røed 1985, Røed et al. 1986, Røed and Whitten 1986). There is as yet, however, no evidence from the historical record of pearyi-sized caribou on arctic islands until ca. 8000 BP; and then, only for northern Greenland (Meldgaard 1986). Caribou antler material from an unknown form of Rangifer found on northern Ellesmere Island also has been dated at ca. 8000 BP (Stewart and England 1986). Thus, the lack of evidence for the presence of ancestral pearyi prior to recent times has led to varying conclusions about where R. t. pearyi obtained refuge from the Wisconsinan-Weichselian glaciation. Much of the reasoning and circumstantial evidence are for the progenitors of today's Peary caribou to have found refuge in the Canadian Arctic Archipelago, probably on the western island of Banks (and possibly southern Prince Patrick Island), possibly on northern Ellesmere Island, and also on northern Greenland (Peary Land) (e.g., Rand 1954, Banfield 1961, 1963, Macpherson 1965, Harington 1971, 1978, 1986, Hakala et al. 1985, Røed et al.

1986, Røed and Whitten 1986, K.H. Røed, pers. commun., 1989; Røed 1991). The considerable genetic differentiation between pearyi and the continental forms of barren-ground caribou (R. t. groenlandicus, R. t. granti) and tundra reindeer (R. t. tarandus) supports the belief that Peary caribou evolved from an ancestral population different from ancestral populations of the barren-ground and tundra forms (Røed and Whitten 1986; K.H. Røed, pers. commun., 1989, Røed 1991). However, Degerbøl (1957) argued against northern Greenland or the Canadian High Arctic Islands having served as refugia for pearyi. Most recently, caribou antler material from eastern Peary Land in North Greenland was carbon-14 dated at ca. 40 000 years BP (Meldgaard and Bennike 1989, Meldgaard 1991). This antler represents the oldest known specimen of Rangifer from high arctic regions; however, the subspecies is unknown. Thus a Sangamonian interglacial age of 130 000 to 74 000 BP is suggested for the evolution of high arctic caribou ancestral to pearyi, eogroenlandicus, and platyrhynchus (Meldgaard and Bennike 1989, Meldgaard 1991). It is argued that although ice-free areas existed in North and Northeast Greenland, northern Ellesmere Island, and also on Svalbard, the weather was too cold there during the Wisconsinan-Weichselian glaciation to permit the growth of vegetation necessary for caribou survival in those areas (Meldgaard and Bennike 1989, Meldgaard 1991). Therefore, if the lack of suitable vegetation for caribou forage is correct, the progenitors of

pearyi-like caribou must have survived the glaciation in refugia such as Banks Island or other high arctic areas of Beringia (e.g., Harington 1978, 1986, Meldgaard 1986, 1991, Meldgaard and Bennike 1989). Peary caribou are not known from Alaska or any Old World location, nor from "Beringia" (the apparent refugium of groenlandicus during the Wisconsinan-Weichselian ice-age).

**B2. Canada**

Peary caribou are uniquely Canadian and the typical characteristics of this subspecies are consistantly displayed by those Peary caribou on the Queen Elizabeth Islands (Manning 1960, Banfield 1961). Peary caribou on the Queen Elizabeth Islands are a genetically homogeneous inter-island population (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed et al. 1986). In contrast, to date, no evidence has been obtained to even suggest that any regular interchange of caribou is occurring or has occurred in recent times between the Queen Elizabeth Islands and the southern tier of islands (Banks, Victoria, Stefansson, King William, Prince of Wales and Somerset: only barren-ground caribou are known from Baffin and Bylot islands and their satellite islands). Sporadic ingress of some arctic-island caribou would be possible, however, especially as the result of widespread wintertime environmental stress (cf. Thomas et al. 1976).

The caribou on the arctic islands south of the Queen Elizabeth Islands are referred to as "arctic-island caribou"

in this report to emphasize their genetic diversity from pearyi and also their likely ecological diversification. The cline of increasing size of the caribou on the southern tier of islands compared to caribou on the Queen Elizabeth Islands led Manning (1960), Banfield (1961) and Thomas and Everson (1982) to suggest that those arctic-island caribou originated from intergrades of pearyi and groenlandicus. Subsequently, Røed et al. (1986) documented significant diversion in the genetic endowment of Peary caribou from the western Queen Elizabeth Islands compared to arctic-island caribou from Somerset and Prince of Wales islands and also from caribou on the Boothia Peninsula, based on both the types and frequencies of transferrin alleles found in each group by polyacrylamide gel electrophoresis. However, the role of natural selection and isolation mechanisms as well as infraspecific interbreeding cannot be discounted in any evaluation of the variation in morphometric measurements and genetic materials examined to date. To continue to refer to those arctic-island caribou as intergrades could leave an impression that intergradation is still occurring on a large scale. The existing evidence suggests that intergradation between pearyi and groenlandicus is not a significant consideration at this time. (1) Heterozygote deficiences detected in samples of caribou from the western Queen Elizabeth Islands vs. those from Somerset and Prince of Wales islands vs. those from the Boothia Peninsula indicated that present outbreeding among

caribou in those areas is insignificant (Røed et al. (1986). (2) Current knowledge of the caribou rutting distributions on Banks and Victoria islands suggests continued large scale (or possibly any) intergradation is unlikely (A. Gunn, pers. commun., 1989). (3) There is no evidence for present day occurrence of barren-ground caribou on Somerset or Prince of Wales islands.

Banks Island caribou were first reported as being intergrades of pearyi and R. t. arcticus (now R. t. groenlandicus) by Manning (1960) while investigating the relationship of Peary caribou and barren-ground caribou. He concluded that characteristics of the Banks Island intergrades favoured pearyi. However, his classification of Banks Island intergrades as "Peary caribou" rather than pearyi > groenlandicus was seemingly encouraged mainly by his comparison of them to the intergrades of the Dolphin and Union herd that favoured groenlandicus, rather than by the actual taxonomical position of the specimens from Banks Island. Banfield (1961) subsequently also identified essentially the same series of specimens as intergrades of pearyi and groenlandicus. However, in his revision of the genus Rangifer, he too lumped them as "Peary caribou" rather than as intergrade forms of pearyi > groenlandicus or groenlandicus > pearyi. Had Manning (1960) and Banfield (1961) been "taxonomical splitters", they would have brought out this distinction in genetic diversity among the arctic-island

caribou of Banks Island and the Peary caribou on the Queen Elizabeth Islands in a more obvious manner.

The arctic-island caribou of northwestern Victoria Island appear to exhibit the same characteristics favouring pearyi as do the intergrades of pearyi and groenlandicus on Banks Island, and the two groups may have previously existed as a common inter-island population. There is, however, no evidence for large-scale current migrations between Banks and Victoria islands, although evidence for limited, sporadic movements of caribou between eastern Banks Island and northwestern Victoria Island has been reported (McEwen 1952a, 1952b, 1955, Manning and Macpherson 1958, Manning 1960, Miller and Gunn 1978a).

The recorded occurrence of pearyi on northwestern Victoria Island was based upon Inuit reports and aerial surveys but was not substantiated by specimens (Banfield 1961). Manning (1960) had described, however, the resident arctic-island caribou as intermediate between pearyi and the now supposedly extinct caribou on Victoria Island of the Dolphin and Union herd.

The Dolphin and Union herd summered on Victoria Island and returned to the mainland after the rut in early November when the Dolphin and Union Strait and Coronation Gulf were refrozen. The disappearance of the migrant herd parallels the introduction of firearms and by the end of the 1920s the movement had all but stopped (Manning 1960). Loss of the

Dolphin and Union herd likely left some members on Victoria Island, though Manning (1960) believed, for unstated reasons, that the number remaining on Victoria was low.

The relationship between those remaining individuals of the Dolphin and Union herd and the then remaining Peary-like stock is unknown. Caribou numbers remained low on Victoria Island until the 1970s (Gunn 1990). Whether the caribou currently on Victoria Island arose from the remnants of the Dolphin and Union herd (favouring groenlandicus) or the resident caribou (favouring pearyi) remains unknown. Currently, arctic-island caribou of Victoria Island in the northwestern portion of the island are similar in appearance to the Banks Island caribou. Interchange between these groups appears to be minimal (A. Gunn, F.L. Miller, and D.C. Thomas, unpublished data). The caribou on southern, eastern and central Victoria Island are larger but still are more similar to Peary than barren-ground caribou in pelage colouration and body conformation. Their skull measurements are similar to the former individuals of the Dolphin and Union herd (A. Gunn, pers. commun., 1987). Most recently, K.H. Røed (pers. commun., 1989) used blood samples collected by Dep. Renewable Resources, GNWT, biologists and found by analysis of transferrin variation that the genotype of Victoria Island caribou has a greater genetic similarity to that of barren-ground caribou from the Beverly herd on the central mainland than to pearyi from the Queen Elizabeth Islands.

The taxonomical status of the arctic-island caribou currently found on Stefansson Island is unknown. However, they likely are most closely linked to the caribou of northeastern or eastern Victoria Island.

The taxonomical position of the arctic-island caribou currently found on King William Island (and the lesser islands of the area, including Admiralty, Gateshead, Jenny Lind, Matty, Tennent, and Royal Geographical Society) is unknown. Caribou shot on Gateshead Island in March 1986 were similar to those on eastern Victoria Island (A. Gunn, pers. commun., 1989). Only four caribou were seen on King William Island during aerial survey in 1986 and they were Peary-like in appearance (A. Gunn, pers. commun., 1989) as were the few caribou also seen on Matty Island. King William and the lesser islands of the area are reported by Inuit hunters to have Peary-like caribou immigrants or migrants from the southern Boothia Peninsula and some migrant barren-ground caribou from the Adelaide Peninsula (A. Gunn, pers. commun., 1989). The mass numbers of summer migrants from the mainland to King William Island prior to the 1930s (Klutachak 1987) were supposedly composed of barren-ground caribou, but possibly could have also included some arctic-island caribou (cf. Dolphin and Union herd).

The arctic-island caribou of Prince of Wales Island, Somerset Island (and their associated satellite islands), together with the Boothia Peninsula north of its isthmus

should not be considered separately, as many of those caribou migrate seasonally within the island-peninsula complex (e.g., Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981). Large-scale north-south migrations of barren-ground caribou on the Boothia Peninsula continued at least occasionally to Somerset Island prior to the 1930s (Macpherson 1959), and lesser numbers were believed to have crossed from the Boothia to Prince of Wales Island (Manning and Macpherson 1961). Again, these may have been arctic-island or typical barren-ground caribou.

Caribou on Prince of Wales Island were originally classified as a "super" pearyi deme by Manning and Macpherson (1961) based on only seven specimens of large adult caribou shot in summer. They concluded that the caribou that they had examined appeared diagnostically as ultra pearyi, and showed no significant intergradation with groenlandicus. Banfield (1961) accepted the conclusion of Manning and Macpherson (1961) after examining the same seven specimens. This conclusion appears to have been fortified by the belief that although it was known that barren-ground caribou crossed from the Boothia Peninsula to both Somerset and Prince of Wales islands, supposition at that time had it that they apparently did not intermingle or breed with the island caribou (Macpherson 1959, Manning 1960, Banfield 1961, Manning and Macpherson 1961).

Subsequently, however, Thomas and Everson (1982) examined

a relatively large series of caribou shot in late winter on Prince of Wales Island and concluded that intergradation of pearyi and groenlandicus had taken place. Thomas and Everson (1982) also examined caribou from Somerset Island and the Boothia Peninsula, with individuals from both of those locales also exhibiting apparent intergradation between pearyi and groenlandicus. Thomas and Everson (1982) believed that they clearly showed, contrary to the conclusions of Manning and Macpherson (1961), that similar phenotypic clines exist on southwestern islands (Banks and Victoria) and southeastern islands (Somerset and Prince of Wales) northward to the Queen Elizabeth Islands. They further stated that the so-called Prince of Wales Island "ultra" pearyi of Manning and Macpherson (1961) was most certainly a summer visitor to Prince of Wales Island (possibly from Victoria Island), similar to the five large caribou bulls in their August 1978 sample (Thomas and Everson 1982). Such large-sized males could also have come as summer visitors from the Boothia Peninsula, based on spring observations of large male caribou on the sea ice, crossing from the Boothia to Prince of Wales (cf. Miller and Kiliaan 1980a, 1981).

Therefore, the arctic-island caribou of Prince of Wales Island, Somerset Island, and caribou of the northern Boothia Peninsula include apparent intergrades of pearyi and groenlandicus (some pearyi > groenlandicus and some groenlandicus > pearyi) and possibly an ultra pearyi deme and

also some groenlandicus individuals. In terms of phenotypic and genetic characteristics these arctic-island caribou have diversified from the Peary caribou found on the Queen Elizabeth Islands (cf. Røed et al. 1986).

The characteristics of Peary caribou are expressed in ascending clines from south to north on the Canadian Arctic Archipelago (Manning 1960, Banfield 1961, Thomas and Everson 1982) and marked genetic diversity has been shown among each of these clines (Røed et al. 1986, 1991). Therefore, in terms of the greatest development of pearyi characteristics and genetic endowment, essentially all of the southern tier of islands in the archipelago have been lost by Peary caribou to arctic-island caribou that may have originated as intergrades of pearyi and groenlandicus and possibly also through the forces of extreme natural selection or isolation mechanisms. Therefore, over half (ca. 53%) of the original probable, usable range of Peary caribou in Canada has been lost since historic times. Peary caribou would be at a disadvantage when competing with the larger arctic-island caribou on the southern tier of islands and especially when competing with groenlandicus on the mainland (or on Baffin or Bylot islands). In the presence of other forms of Rangifer and under present climatic conditions the Peary caribou could not extend its range southward beyond the Queen Elizabeth Islands without changing its typical morphometric characteristics. Thus, the Queen Elizabeth Islands of the Canadian Arctic Archipelago are

all important to the current and future preservation of the Peary caribou and its gene pool. It now appears that viable populations of these Peary caribou occur only on the Queen Elizabeth Islands of Canada.

Peary-like caribou sporadically occur on mainland areas possibly as a result of forced movements when widespread forage unavailability is brought on by deep snow and/or icing conditions on their island home ranges. Environmentally forced movements have been suggested for caribou on Banks Island (McEwen 1955, Manning and Macpherson 1958). Such occurrences are usually on the mainland coast, but in winter 1963-64 a Peary-like caribou (most likely from Banks Island) was killed at Old Crow in the Yukon: an adult female that most closely resembled a Dolphin and Union herd intergrade (Youngman 1975). Low numbers of arctic-island caribou from Victoria Island regularly cross the sea ice to the mainland in November, winter in the area of Elu Inlet, then return in April to southeast Victoria Island; thus, mimicking on a small scale the seasonal migration pattern of the Dolphin-Union herd (A. Gunn, pers. commun., 1989).

## C. Protection

Peary caribou and the arctic-island caribou are the management responsibility of the Government of the Northwest Territories. There are no restrictions on subsistence hunting of caribou by holders of "General Hunting Licences". However, a voluntary ban was imposed in 1975 by Inuit of Resolute Bay on hunting caribou on Bathurst Island after the massive 1973-74 winter die-off (Freeman 1975). In 1982, the Resolute Inuit extended their ban on caribou hunting to include Cornwallis Island and those small islands interjacent to Bathurst and Cornwallis (Ferguson 1987). In response to a lack of caribou, the Grise Fiord Inuit imposed a 10-year band on caribou hunting on a large part of Ellesmere Island in 1986 (Ferguson 1987). The people of Grise Fiord subsequently obtained their caribou meat during the late 1980s by purchasing it from the Resolute Bay Hunters and Trappers Association, who had harvested the caribou on Somerset Island. More recently, Grise Fiord hunters have hunted caribou on Somerset Island and flown the meat back to Grise Fiord.

Arctic-island caribou on the southern tier of islands and caribou on the Boothia Peninsula are also subjected to low levels of meat and sport hunting by non-native resident hunters. A limited number of "commercial tags" (220 available in 1988: 95 Sachs Harbour; 75 Cambridge Bay; and 50 Holman) are issued annually to holders of "General Hunting Licenses" (A. Gunn, pers. commun., 1989). These tags allow the sale of

meat to individuals or commercial establishments within the Northwest Territories, guided trophy hunting for non-residents, and local sales of meat to hotels or individuals.

## D. Population Size And Trend

Determination of population sizes and trends for Peary caribou on the Queen Elizabeth Islands and the arctic-island caribou on the southern tier of islands in the Canadian Arctic Archipelago is handicapped by insufficient survey data. Comparative survey information exists only for the southwestern and southcentral Queen Elizabeth Islands and Banks, Prince of Wales, and Somerset islands (and those data bases are variable and fragmentary). The handicap is increased as much of the existing information on numbers of caribou has been derived from only a portion of an island rather than the entire island or a single island without regard to the effect of inter-island migrations. Additionally, surveys were frequently flown against a background of snow, or even worse, when the ground was mottled snow cover and snow free areas. Against such a background, the caribou are inconspicuous from the air. Thus, the following discussions of trends in population size are based on only those aerial surveys least likely to have survey problems. However, other survey results are used when such use apparently adds to the evaluation or when no other data exist.

### D1. Queen Elizabeth Islands

Numbers of Peary caribou have declined significantly throughout their range on the Queen Elizabeth Islands over the 26 years from 1961 to 1987 and the decline is likely to

continue in the absence of any marked climatic improvement. The first estimate of 25 845 Peary caribou on the Queen Elizabeth Islands was obtained by aerial survey in summer 1961 (Tener 1963).

Available information indicates that by 1987, there were only 3300-3600 Peary caribou left in the Canadian High Arctic and all occurred on the Queen Elizabeth Islands. Almost 75% of those Peary caribou now occur on several islands which are only about 1/5th of the landmass of the Queen Elizabeth Islands. Only the major islands of Melville, Bathurst, and Prince Patrick, and their lesser satellite islands have potential for supporting relatively high densities of Peary caribou. Thus, nearly 4/5th of the landmass of the Queen Elizabeth Islands serves merely as a reservoir that supports only extremely low-density populations over the long-term on a year-round basis.

Southwestern Queen Elizabeth Islands

The island complex of Melville, Prince Patrick, Eglinton, Byam Martin, and Emerald has a landmass of about 61 310 $km^2$ which is about 15% of the entire Queen Elizabeth Islands (Table 1). This land area was the most important island complex for Peary caribou within the Queen Elizabeth Islands. In 1961, nearly 60% of all the Peary caribou estimated on the Queen Elizabeth Islands (N = 25 845) occurred on this island complex (Table 1), with a mean density of 25.1 caribou · 100 $km^{-1}$. By summer 1973, the estimated number of Peary caribou

within the complex had dropped to 28% (mean density, 7.1 caribou · 100 $km^{-2}$) of the 1961 estimate. Then, in the extremely severe winter of 1973-74 nearly half (46%) of the caribou remaining in summer 1973 died and the estimated number of caribou in summer 1974 was reduced to 15% (mean density, 3.8 caribou · 100 $km^{-2}$) of the 1961 estimate. Finally, by summers 1986 and 1987 the estimated number of Peary caribou within this island complex had declined further to only about 8% (mean density, 2.1 caribou · 100 $km^{-2}$) of the 1961 estimate.

Those data indicate that Peary caribou on the southwestern Queen Elizabeth Islands declined by nearly 92% between 1961 and 1987. There is no evidence for any periods of stability or reversal in the overall decline, although some brief periods of reprieve might have occurred. This inter-island population shows no apparent signs of recovery in the near future. The population is too small to sustain any harvest beyond a nominal level.

The Peary caribou on Melville Island have not become extinct by 1983 as forecasted by a worst-case scenario by Thomas and Joly (1981). Also, adult male caribou contrary to Thomas and Joly's (1981) belief, appear well represented in the population on Melville Island at ca. 32% (N = 337 1+ yr-old caribou) seen in July 1987 (Miller 1988). However, at least a decade must pass before the Peary caribou population on Melville Island could likely increase significantly enough to sustain an annual harvest of any appreciable size.

The rapidly increasing number of muskoxen (Ovibos moschatus) within this island complex (Miller 1988) is possibly significant in the ecology of Peary caribou. The increase in the muskox numbers will enlarge the prey base for wolves (Canis lupus). If the wolves respond numerically to the greater prey base, the wolves could then seriously affect the caribou population, as even incidental predation could be significant on a proportionate basis for the markedly reduced number of caribou.

South-central Queen Elizabeth Islands

The total landmass (26 620 km²) of the island complex of Bathurst, Cornwallis, Vanier, Cameron, Alexander, Massey and Little Cornwallis is about 6% of the entire Queen Elizabeth Islands (Tables 1, 2, 3). This land area is the second and the only other important area of the Queen Elizabeth Islands in terms of the past and likely future potential for eventually producing, at least, moderate numbers of harvestable Peary caribou.

In 1961, nearly 14% (3608) of the Peary caribou estimated on the Queen Elizabeth Islands occurred within this island complex (Tables 1, 2, 3), with a mean density of 13.6 caribou · 100 $km^{-2}$. By summer 1973, the estimated number of Peary caribou was about 22% (797 at a mean density of 3.0 caribou · 100 $km^{-2}$) of the 1961 estimate. Then, as elsewhere throughout at least the western and central Queen Elizabeth Islands, a catastrophic die-off (ca. 67%) occurred during the winter of

1973-74, and by summer 974, the estimated number of Peary caribou had been reduce l to only about 7% (262 at a mean density of 1.0 caribou 100 km$^{-2}$) of the 1961 estimate. In summers 1985 and 1988, however, the estimated numbers of caribou had increase almost three- and four-fold, respectively, from 1974 (mean density in 1985, 2.7 caribou · 100 km$^{-2}$; 1988, 4.1 car bou · 100 km$^{-2}$)(Miller 1987a, 1989, 1991a, b). However, the 1985 and 1988 summer estimates still only represent about 20 (727) and 31% (1103) of the Peary caribou estimated with: this island complex in 1961 (no significant difference etween 1985 and 1988 estimates, P >0.05). Thus, the over ll trend has been steeply downward from 1961 to at least 19 4; then, likely a gradual upswing in the early 1980s. Fische: and Duncans' (1976) estimates of 332 caribou in August 1974 and 361 caribou in June 1975 add further support to the vidence for a catastrophic decrease from summer 1973 to sum er 1974 and are in close agreement with Miller et al.'s (19 7a) estimate of 256 ± 143 in summer 1974. That the turnaro nd did not occur until some time in the 1980s is supported b the estimate of 289 ± 93 caribou on Bathurst Island in summe · 1981 (Ferguson 1987). Whether the changes observed and est mated in 1985 are the beginning of a relatively long-term t end or only a brief reversal in direction cannot be dis erned at this time. However, the inter-island population ithin this island complex is not yet at a level that would su tain any appreciable level of annual

harvests. Self-restraint and the continuance of the total ban on caribou hunting on Bathurst Island should be encouraged for at least the next several years. However, a token harvest of less than 10 male caribou may be necessary for the maintenance of Inuit cooperation, as 12 years (1975-87) of no caribou hunting on Bathurst Island has already passed.

Northwestern Queen Elizabeth Islands

This complex of islands, sometimes called the "Prime Minister Group", includes Mackenzie King, Borden, and Brock (8610 $km^2$) and is only 2% of the entire Queen Elizabeth Islands (Table 2). In 1961 nearly 16% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred on this island complex (Table 2). The unusually high mean density of 46.6 caribou · 100 $km^{-2}$ in summer 1961 was probably a seasonal overflow of summer migrants from the major islands of Melville, Prince Patrick, and even Bathurst. Evidence from tracks on the sea ice and changes in numbers of caribou occurring there among years supports this assumption (Stefansson 1921, Macpherson 1961, Tener 1963, Miller et al. 1977a). Survey results from April 1973 and April 1974 indicated that only a remnant population of about 1% of the 1961 estimate still occurred within the complex (Miller et al. 1977a). No subsequent surveys have been flown but hearsay information from non-wildlife biologists who were in the area during summers in the late 1970s and the early 1980s suggest that caribou continue to be rare there.

This island complex is unsuitable for year-round occupation by ungulates at high densities because of extremely limited forage and the landmass is relatively insignificant in size compared to the remainder of the Queen Elizabeth Islands. Thus, this island complex's real value to Peary caribou is as supplementary summer range during periods of population highs on the southwestern and south-central islands and as a low density reservoir during population lows on other areas.

North-central Queen Elizabeth Islands

The islands of Ellef Ringnes, Amund Ringnes, Cornwall, Graham, Lougheed, Meighen, King Christian, and North Kent (23 700 $km^2$) represent about 6% of the entire Queen Elizabeth Islands (Table 3). The only population estimate for this island complex was obtained in 1961 when about 8% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred in this island complex (Tables 1, 2, 3), with a mean density of 9.1 caribou · 100 $km^{-2}$. Only Lougheed Island has been aerially resurveyed since 1961: 56 caribou were estimated there in April 1973 and only one was seen there in April 1974 (Miller et al. 1977a). More recently, only one cow-calf pair (and a mature bull on Edmund Walker Island just off the southeast coast of Lougheed Island) were seen during an aerial survey of Lougheed Island in July 1985 (Miller 1987a).

The relatively high number of caribou in this area in summer 1961 was likely also an overflow of summer migrants

from southwestern and south-central islands. This condition is especially true for Lougheed Island, which seemingly could not have supported such a high density of caribou on a year-round basis. Hearsay evidence from non-wildlife biologists in the area during summer in the 1980s also suggests that densities of caribou continue to be low on the island. Like the northwestern islands, this island complex is likely only suitable for supporting summer migrants, sometimes at relatively high densities, but could only sustain low-density reservoir populations during wintertime.

Eastern Queen Elizabeth Islands

This complex includes the three largest of the Queen Elizabeth Islands: Ellesmere, Devon, and Axel Heiberg, with a total landmass of 294 670 $km^2$, or about 71% of the entire Queen Elizabeth Islands (Table 3). In 1961, less than 3% of all the Peary caribou estimated on the Queen Elizabeth Islands occurred in this island complex (Table 3), with an extremely low mean density of 0.2 caribou · 100 $km^{-2}$. The islands have not been surveyed since 1961, but hearsay information from biologists and non-wildlife biologists in the area indicates that while Tener's (1963) 1961 estimates for the three islands within this complex might be on the low side, they are not significantly so. For unknown reasons, these large islands have apparently never supported large numbers of Peary caribou.

Until the mid 1980s, the limited harvest of Peary caribou

on southern Ellesmere Island likely seriously affected the population size. This problem was first identified in the early 1970s, when Riewe (1973) reported that then current annual harvests averaged 26 caribou, only slightly more than half as large as the 43 averaged in the early 1980s. In 1986-87 the harvests dropped to 25 caribou annually (M.A.D. Ferguson, pers. commun., 1989).

There is no reason to believe that these islands will ever serve as anything but very low-density reservoirs for Peary caribou. The caribou population in this island complex will likely never be able to sustain annual harvests of any significant level, unless climatic change leads to more favourable future range conditions.

**D2. Southern Tier of Islands - South of 74°N**

Population estimates of caribou on the southern tier of islands (also known as the mid-arctic islands of the Canadian Arctic Archipelago) have no common benchmark starting point and the associated trends are, for the most part, vaguely discernible and their interpretations provisional at best. Detailed annual harvest data for caribou on these islands are only available since 1984 for Victoria Island and 1986 for Banks Island (A. Gunn, pers. commun., 1989).

The available estimate for the entire southern tier of islands (excluding Baffin and Bylot islands) and the Boothia Peninsula (north of 71°10'N) is 18 000-22 000. Existing annual harvest data and our knowledge of the species lead to

the conclusion that this estimate must be too low. Even 20 000 caribou could not collectively sustain the annual combined harvests of about 4000 per year (or 20% annually of all the caribou currently estimated on these islands). The alternative suggestion is that one or more of the island's population estimates is a substantial underestimate, most likely the 1980 estimate of caribou on Victoria Island.

Victoria-Stefansson islands

Together Victoria Island (217 290 km²) and Stefansson Island (4460 km²) represent ca. 61% of the 365 880 km² landmass of the 11 islands in the southern tier in the Canadian Arctic Archipelago (excluding Baffin and Bylot islands and their lesser satellite islands) that each exceed 400 km² in size (Table 4). Victoria Island, seemingly, has the greatest potential for long-term support of a high density population of caribou. Manning (1960) described the disappearance of the Dolphin and Union herd of caribou that used to summer on Victoria Island. Subsequently, caribou have increased in number on Victoria Island (Gunn 1990) and ongoing studies are describing the seasonal movements and taxonomy of the caribou (e.g., Gunn and Stenhouse 1988). The caribou of Victoria Island have been aerially surveyed only once, and that survey did not cover Stefansson Island or northeast Victoria Island (Jakimchuk and Carruthers 1980, 1983).

In view of the fact that 1982-87 reported annual harvests of caribou on Victoria Island are 1700-2300 (Gunn et al. 1986,

A. Gunn, pers. commun., 1989), the August 1980 population estimate (Table 4) must be considered low, as it is biologically impossible for the species to sustain such yields over time. Even at the upper limit of the 95% confidence level of the 1980 estimate, the 10 000 caribou could not sustain a 17-23% yearly harvest without declining markedly within several year's time.

Hunters report increasing numbers of caribou on southern Victoria Island (A. Gunn, pers. commun., 1989) which suggests that as annual mean harvests are approaching or exceed 2000 caribou, the current population is more likely actually about 4-fold the 1980 estimate (i.e., ca. 30 000 strong), if the population is sustaining itself. The current trend for caribou on Victoria Island has not been measured, however. Therefore, the magnitude of the apparent necessary increase could be misleading. If so, the caribou population on Victoria Island could be in an initial stage of decline, even though recent numbers might seem high to hunters. Redistribution of caribou on seasonal ranges without significant increase in number could create a possibly false impression of plenty.

Banks Island

Banks Island (70 030 km²) is about 19% of the landmass of the southern tier of islands (Table 4). The estimated size of the caribou population on Banks Island has decreased by 92% over the 20-year period between 1972 and 1991 (Table 4).

Differences among the 1972 survey results and the results from six subsequent surveys from 1979 to 1991 (Table 4) indicate that the caribou population on Banks Island has been in a state of decline from the 1970s until the present (1991). The decline cannot be explained by the reported annual harvests alone during that time period. However, a high winter die-off of caribou occurred on Banks Island in winter 1977-78 (Morrison 1978). Thus, the combined effects of severe winters and hunting pressure seemingly have contributed to this apparent decline. The 1985 and 1987 estimates of the size of the caribou population on Banks Island (Table 4) and annual harvests of 400-600 caribou suggests that hunting pressure alone from that point onward could have accelerated the population decline. This condition would have been compounded if the caribou were also sporadically subjected to winter die-offs during any of those winters as they apparently have been in the past (cf. McEwen 1955, Manning and Macpherson 1958, Morrison 1978, Vincent 1979).

A marked further drastic decline in the size of the caribou population on Banks Island was reported in 1989 (Table 4: McLean and Fraser, 1991). When their 1989 summer population estimate of 2660 1+ yr-old caribou was adjusted for the 25% calves in the population in summer 1989 (Table 4), the population still remained at less than 30% of the 1972 estimate for caribou on Banks Island (Table 4). This significant reduction in the Banks Island caribou population

from the early 1970s to 1989 was attributed by McLean and Fraser (1991) mainly to overwinter mortality and human harvest. Reported rates of harvest by Sachs Harbour Inuit from 1986 to 1989 averaged 328 ± 77 (SD) caribou (B. McLean, pers. commun., 1991), and it appears that harvest could have markedly accelerated the then current rate of decline.

An aerial survey of caribou on Banks Island was carried out in September 1990 but the resultant extremely low estimate of ca. ± 500 animals was set aside as inaccurate, because of frequent periods of poor visibility caused by unfavourable weather conditions during the survey (B. McLean, pers. commun., 1991). However, the data did suggest that the possibility of severe mortality between 1989 and 1990. The reported harvest of caribou in 1989 (n = 314) and 1990 (n = 102) (B. McLean, pers. commun., 1991) averaged 208 ± 150 (SD) caribou. Those annual harvests appear likely to have been, at least in part, a significant contributor to the decline in the size of the caribou population on Banks Island at least from 1989 onward.

By June 1991, the Banks Island caribou population was estimated by aerial survey at less than 1000 animals (Table 4). This estimate represents more than a 12-fold decrease in the size of the caribou population on Banks Island in a 20-year period (1972-1991).

At present, due to the currently estimated small size of the Banks Island caribou population, annual harvest alone is

now capable of causing continual decline (and rapidly so, if near future annual rates of kill approach those experienced between 1986 and 1989, or earlier). This serious situation on Banks Island warrants special attention, as the recent drastic decline and any near future decrease in the caribou population could be mistakenly attributed to a supposed competition between caribou and muskoxen rather than to the real causes (see G. Limiting Factors).

Prince of Wales Island-Somerset Island-Boothia Peninsula Complex

The islands of Prince of Wales, Somerset, Russell, and Prescott are included in this complex, with a total landmass of about 59 480 km², or about 16% of the southern tier of islands (Table 4). Also included in this complex is the Boothia Peninsula north of 71°10'N, with a land area of about 26 000 km² (Table 4).

Many, if not most, of the caribou migrate freely among the islands and the peninsula within this complex (e.g., Miller et al. 1982). Thus, the existing population estimates suffer from not covering all three major areas within the island-peninsula complex at the same times. This condition confounds evaluation of the trend for the estimates of size of the inter-island (peninsula) population.

The best estimates appear to be for summers 1974, 1975, and 1980 (Table 4). However, the timing of the surveys in 1974 and 1975 were too early, as inter-island or island-

peninsula migrations would have still been occurring in June of those years. Subsequently, the survey results are lacking because the Boothia Peninsula was not surveyed in July 1980. The June 1985 estimate of 4000-5000 caribou on the Boothia Peninsula north of 71°10'N (Gunn and Ashevak, in prep.), in the absence of survey information from the remainder of the complex, leads to at least three possible interpretations: (1) the number of caribou has increased on the northern Boothia Peninsula since 1975; however (2) many caribou might not have yet moved from the Boothia Peninsula to Prince of Wales or Somerset islands before the aerial survey took place in June 1985; or (3) for unknown reasons, caribou that normally summered on Prince of Wales and Somerset islands moved to the Boothia Peninsula before the aerial survey took place and inflated the number of caribou seen there in June 1985.

The existing information for this complex (Table 4) suggests that an inter-island (peninsula) population of about 6000 caribou has existed within the area since at least 1974. The suggested annual harvest of 200-300 caribou from Prince of Wales and Somerset islands is seemingly within the sustainable capacity of the estimated population. The relatively high recent annual harvests (1983-84) of 1100-1300 caribou by Spence Bay residents could impact on this population, but that effect depends on what proportion of the annual kills come from the caribou of this inter-island (peninsula) population

or from the year-round resident mainland caribou. Currently, however, there is no segregation of harvest data from the Boothia Peninsula to allow an evaluation of this potentially serious situation.

King William Island and some lesser islands

This complex includes the islands of King William, Royal Geographical Society, Matty, and Jenny Lind, with a total landmass of about 14 620 km² or only 4% of the southern tier of islands (Table 4).

King William Island once supported large numbers of summer migrants from the mainland, which were presumed to have been barren-ground caribou. However, those large, seasonal migrations declined rapidly in the 1920s, which paralleled the introduction of firearms into the area and a severe winter. Then, the migration from the mainland apparently ceased in the 1930s. Subsequently, caribou apparently have remained rare on King William Island. The only aerial survey of King William Island was carried out in June 1986 under poor survey conditions. Only two caribou cows and newborn calves were seen (Gunn and Lambert, in prep.), although hunters report increasing numbers of caribou on the island. Thus, no population estimate exists for the complex; but all existing hearsay information indicates that few caribou currently occur within this island complex. The potential for this island complex to support a significant year-round population of caribou is limited by the size of the available range and,

seemingly, also by the probable restricted availability and poor quality of the predominantly lowland winter ranges.

## E. Habitat

### E1. Distribution

Icefields, bare ground, and rock restrict the areas of suitable foraging habitat for Peary caribou to a relatively small percentage of the total area of the arctic islands (Gunn et al. 1981). Parker and Ross (1976) described summer ranges used by Peary caribou from sites on Melville and Axel Heiberg islands. Winter and summer range types used by arctic-island caribou have been described along the proposed routes of the Polar Gas pipeline on Prince of Wales and Somerset Islands (Russell et al. 1978) and Wilkinson et al. (1976) described summer range on Banks Island.

Peary caribou and arctic-island caribou use poorly to moderately vegetated xeric to mesic habitats (e.g., Thomas and Edmonds 1983, 1984). Forage of high digestibility is selected but when unavailable, the proportions of low digestibility forages are increased (Thomas and Kroeger 1980). Summer foraging areas often occur on more mesic habitats such as slopes of river valleys and upland plains with sedges (Carex spp.), willow (Salix arctica), grasses, forbs, and herbs, especially Saxifraga oppositifolia (Gunn et al. 1981). In winter, caribou are found on more exposed sites with shallow snow cover such as hilltops and raised beach ridges (Gunn et al 1981). On Somerset Island, the winter range is mainly broken rock outcrops where the snow depth is variable but usually soft or loose and not usually crusted (Thomas et al.

1977). Winter foraging sites tend to be xeric and poorly vegetated with Dryas integrifolia, Saxifraga oppositifolia, Salix arctica, sedges, and lichens as important species, but regional differences are evident (Wilkinson and Shank 1974, Parker and Ross 1976, Thomas et al. 1976, 1977, Wilkinson et al. 1976, Parker 1978, Russell et al. 1978, Shank et al. 1978, Thomas and Broughton 1978, Thomas and Edmonds 1983, 1984).

Caribou characteristically feed while walking and this mobility reduces foraging pressure on the vegetation (Parker and Ross 1976, Miller et al. 1982). Grasses and sedges have a high root:shoot ratio and manifest some capacity for recovering from clipping and probably from foraging (Babb 1978). Herbs and woody prostrate shrubs such as Dryas integrifolia, Saxifraga oppositifolia, and Salix arctica are physically more resistant to damage such as by trampling, but probably less resistant to heavy pruning (Babb 1978). On the North American mainland, fruiticose lichen communities are vulnerable to trampling damage by caribou (e.g., Pegau 1970). On the arctic islands the low numbers of caribou and relative unimportance of the poorly developed lichen stands in their diet apparently minimize the effect of caribou on lichens (e.g., Thomas and Edmonds 1983). The low densities of Peary caribou, the relative small size of their groups, and their mobility while foraging usually prevent overuse of forage sites despite the characteristically low productivity of such ranges (Gunn et al. 1981).

Calving, postcalving and rutting areas likely are critical habitats, and the caribou using them are particularly vulnerable to harassment by man's activities (Miller and Gunn 1979b). Unfortunately, no knowledge of those areas exists for the High Arctic Islands and documentation is still fragmentary for the southern tier of islands; thus, evaluations of these habitats are lacking or incomplete. The surveys of the western Queen Elizabeth Islands during 1972-74 were flown in July and August, too late to identify calving areas (Miller et al. 1977a), but the Dundas Peninsula (southeast Melville Island) was identified as an important postcalving area (Miller et al. 1977a). Urquhart (1973) identified possible calving areas for arctic-island caribou on Banks Island in 1971. The most important was Ballast Beach on the northwest side of the island, but cows also calved in many other areas of the northern half of the island (Urquhart 1973). On Somerset Island, the Inuit believe Aston Bay is an important calving area, but Miller and Gunn (1979a) suggest the calving takes place south of Aston Bay. It also appears that the north and northwest coastal areas of Prince of Wales Island may be alternate calving areas to the west coast of Somerset Island (Miller and Gunn 1979a). On the Boothia Peninsula, caribou have calved south of Wrottesly Inlet south to Pasley Bay (Gunn and Ashevak, in prep.). On Victoria Island, caribou calve north of Minto Inlet and south of Prince Albert Sound (A. Gunn, pers. commun., 1989).

**E2. Trend In Quantity Of Critical Habitat**

In ungulate management, winter range is usually regarded as controlling the upper limits of a population. In the High Arctic, summer range may be as critical as winter range because the growing season is so short for the caribou to build up fat reserves (cf. Thomas 1982). There is no evidence that, in the past, either winter or summer habitats were limiting factors in terms of absolute forage production (e.g., Miller et al. 1977a). Ranges on an island basis are difficult to evaluate as caribou move between or among islands (e.g., Miller et al. 1977b, 1982, Miller 1990a). The choice areas of available habitat are small in comparison with the total landmass of the Canadian Arctic Archipelago, and large-scale industrial exploratory and exploitive activities have the potential to reduce or prevent access to, or use of, habitats (cf. Cameron et al. 1979, Cameron and Whitten 1980, Smith and Cameron 1983, Whitten and Cameron 1983).

Localized, potential habitat disturbance or destruction is possible from the use of tracked vehicles, spills of oil, fuel, or drilling mud, and the construction of roads and aircraft landing strips (e.g., Gunn et al. 1981, Gunn 1984). The presence of industrial installations and/or aircraft activities could result in harassment leading to caribou abandoning critical ranges (Miller and Gunn 1979b). It is not only winter and summer habitats that are important habitats to Peary caribou, but also traditional calving, postcalving and

rutting areas (cf. Gunn and Miller 1986). Any interference with caribou leading to a reduction in use of those important traditional areas as well as winter or summer ranges can be regarded as detrimental to the well-being of the Peary caribou and may impact at the population level (Fig. 3).

Abandonment of ranges by Peary caribou due to industrial exploration has not been proven, but has already been implicated in declines of caribou on Bathurst Island by Inuit hunters (Freeman 1975, Miller et al. 1977a, Miller and Gunn 1978a). However, as emphasized by Miller et al. (1977a) and Miller and Gunn (1978a), natural factors such as weather also have to be examined before range abandonment can be correlated with industrial activity related disturbances.

**E3. Protection Of Habitats**

No areas containing Peary caribou habitats are specifically protected to date (Gunn et al. 1981). The Queen Elizabeth Islands Game Preserve was created in 1926, but it only prevented hunting by whites and provided no protection for Peary caribou habitats and was rescinded in 1966. The National Park on Ellesmere Island and the park scheduled for Banks Island may afford some protection to habitats but will not prevent hunting. As noted by Gunn et al. (1981), the Federal Government or the Government of the Northwest Territories could recognize and legislate restrictions on land uses in sites identified by the International Biological Program; then, some protection to habitats may be ensured, but

those identified sites are not important for Peary caribou.

The establishment in 1973 of a traditional hunting area for Inuit and limited restriction of human activities in May-July of each year on western Somerset Island gives limited protection to critical wintering areas and a likely calving area (Gunn et al. 1981). The limited restrictions were made possible under the Northwest Territories Land Act 1973.

**E4. Degree Of Specialization**

If Peary caribou became extinct, no other ungulate could occupy its niche (Gunn et al. 1981). The High Arctic, with its severe climate and low productivity of the vegetation, imposes harsh and often subtle selective pressures, and mainland caribou could not survive without marked evolutionary modifications.

Although the evolution of Peary caribou has led to reasonably successful adaptations to the rigours of the Canadian High Arctic, it has, at the same time, apparently eliminated the ability of Peary caribou to compete successfully elsewhere with other forms of Rangifer. Possibly, genetic alteration of Peary caribou with genes of barren-ground caribou has produced transitional forms of arctic-island caribou that apparently are better adapted to the environmental conditions of the southern tier of islands in the Canadian Arctic Archipelago than are either the pearyi from the High Arctic or groenlandicus from the mainland. Thus, the historic range of Peary caribou in Canada has

already been reduced by more than half of its likely former size.

Even the Peary-like transitional form possibly of pearyi and groenlandicus now on the southern tier of arctic islands would not be successful over the long-term on the High Arctic Islands, without first evolving further toward pearyi. Physiologically and behaviourally there is only one form of Rangifer that can withstand the rigours of the Canadian High Arctic environment - the highly evolved Peary caribou that now occurs there.

There are in reality at least two, and probably three, genotypes of Canadian arctic-island caribou with three discernible phenotypic expressions: pearyi; pearyi > groenlandicus; and groenlandicus > pearyi. Biologically sound preservation and conservation efforts for Peary caribou, and indeed for all Canadian arctic-island caribou, can best be achieved by first recognizing these genetic and phenotypic distinctions. Most importantly, only those caribou of the Queen Elizabeth Islands should be recognized as Peary caribou (all other caribou of the mid-arctic islands of the Canadian Arctic Archipelago should be considered separately as two other genotypes of Rangifer).

## F. General Biology

### F1. Production And Recruitment

There is some evidence from sightings of newborn calves, that at least on Prince of Wales and Somerset islands, calving among some arctic-island caribou occurs in the third week of June (Miller et al. 1982). On Banks Island, calving took place during the first 2 weeks of June in 1971 (Urquhart 1973). Satellite-collared cows calved between 3 and 21 June on Victoria Island in 1987 and 1988 (A. Gunn, pers. commun., 1989). In 1977, most caribou calved in the third week of June on the west coastal area of Somerset Island, but in 1978, after an exceptionally long and severe winter, calving was delayed until the fourth week of June and the cows travelled from Somerset to Prince of Wales Island to calve (Miller and Gunn 1979a). However, Fischer and Duncan (1976) reported cow-calf groups on Somerset and Prince of Wales islands between 15 and 22 June. Thus, those observations seemingly suggest that the timing and location of calving might be influenced indirectly by the severity and duration of the preceding winter (Gunn et al. 1981).

The proportion of bred yearlings on islands such as Somerset and Prince of Wales varied between and among years and apparently reflects their physical condition (Thomas and Broughton 1978, Thomas 1982). Cows between 2 years and about 10-13 years of age potentially can produce a single calf each year, but this potential is probably rarely realized because

of failures to build-up sufficient fat reserves every year (Thomas 1982). Also, in many years when calves are produced they are not successfully reared or they die during the first winter of life (e.g., Miller et al. 1977a).

On Prince of Wales and Somerset islands, pregnancy rates were recorded from arctic-island caribou collected in 1974 through 1977 (Parker et al. 1975, Thomas et al. 1976, 1977, Thomas and Broughton 1978, Thomas 1982). The rates were 40% in 1974, 73% in 1976, 91.7% in 1975, and 100% in 1977. On the western Queen Elizabeth Islands pregnancy rates for Peary caribou in 1974-76 varied from 5.5-7.1% on Prince Patrick and Melville islands after the particularly severe winter of 1973-74, but recovered to 88% in 1977 (Parker et al. 1975, Thomas et al. 1976, 1977, Thomas and Broughton 1978, Thomas 1982). Those pregnancy rates were closely paralleled by the levels of fat reserves - low fat reserves were not observed in pregnant cows (Thomas 1982). The failure to breed is likely the result of insufficient replenishment of fat reserves during the summer after certain winters (Thomas 1982). Unfortunately, there are no data on fat reserves in September-November, at or about the time of the rut (Thomas 1982). It is not known if the low pregnancy rates on Melville and Prince Patrick islands in 1975 and 1976 resulted from 1974-75 and 1975-76 winters being unfavourable, or if it took 2 years to regain physical condition after the severe winter of 1973-74 to reinitiate normal levels of breeding and/or conception again in 1977

(Gunn et al. 1981).

Comparable data on pregnancy rates and calf and yearling counts exists only for arctic-island caribou during 1976 and 1977 on Prince of Wales Island (Miller and Gunn 1978a, 1978b). Unfortunately, the calf and yearling counts were spread over late June to August and possibly include overlap of counts. In March 1976, 73% of cows collected on Prince of Wales and Somerset islands were pregnant (Thomas et al. 1977). In July-August 1976, only 31.2% of the individuals classified as adult cows were accompanied by calves, and calves and yearlings represented 15.9% and 2.2%, respectively, among 1654 caribou segregated on northern Prince of Wales Island (Miller and Gunn 1978b). The following year, all of the nine cows collected on Somerset and Prince of Wales islands were pregnant (Thomas and Broughton 1978). In June-August 1977, the percentage of cows accompanied by calves was considerably higher (85.1%) than in 1976; the percentage of calves of the 294 caribou segregated was 25.2% and the yearling percentage was 3.7% (Miller and Gunn 1978b). The springs of 1976 and 1977 were late and normal, respectively (Miller and Gunn, unpubl. data), though snow conditions in March were similar during both years. The extremely low recruitment of yearlings emphasizes the vulnerability of that age class, and also, in the long-term, the population to any additional mortality.

The percentage of calves in the arctic-island caribou population on Banks Island had remained relatively high and

stable from 1970 to 1973. The apparent increase from 19.1% in June 1970 (Kevan 1974) to 27.9% in June 1971 (Urquhart 1973) was probably due to the greater proportion of cows in the population resulting from differential winter mortality during the severe winter of 1970-71, as bulls and short yearlings were more vulnerable than cows (Urquhart 1973). In July 1972, Boukhout (in Urquhart 1973) segregated 23.9% calves and Wilkinson et al. (1976) estimated 20.0% calves in July-August 1973 on Banks Island. The high percentages of calves on Banks Island probably reflects both the relative luxuriant tundra vegetation found there (Banfield 1961) and relatively favourable weather conditions during certain years.

During the same period on the western Queen Elizabeth Islands, the Peary caribou calf crops were lacking or the percentages of calves were markedly lower and varied between and among years and islands (Miller et al. 1977a). In 1972, there were no calves seen in July-August on Melville Island, but in 1973, 17.7% of the caribou segregated by sex/age were calves, but few or none survived the catastrophic winter of 1973-74. The percentage of calves dropped to 1.1% in 1974. On Prince Patrick Island, calves were 10.7% and 7.0% of the segregated caribou in 1973 and 1974, respectively. The calf crops on the Queen Elizabeth Islands in 1961 were comparable to those in the early 1970s on Banks Island. Tener (1963) found 19.0% and 20.3% calves on Melville and Prince Patrick islands, respectively, in July 1961.

The survival of calves during their first year of life, especially their first winter is usually poor (Gunn et al. 1981). The published highest short yearling count for arctic-island caribou is 11.4% in March 1971 on Banks Island after an apparently severe winter (Urquhart 1973). However, for Peary caribou in June-July 1961 Tener (1963) recorded 3.5% yearlings on Bathurst Island, 4.3% on Melville Island and 5.8% on Prince Patrick Island. Miller et al. (1977a) abandoned their attempts to segregate short yearlings of Peary caribou during March-April aerial surveys of the western Queen Elizabeth Islands because they were not seeing any short yearlings. They suggested that few, if any, calves survived during 1973-74 to the age of short yearlings. The 1972-75 annual recruitment rates of Peary caribou on the western Queen Elizabeth Islands was negligible (Gunn et al. 1981). The lack of recruitment is reflected in the age structure of the population on Melville and Prince Patrick islands: the 20 caribou collected on those islands in 1977 were all aged 7 years or older, the average was 9.9 years and range 7-13 years (Thomas and Broughton 1978).

In contrast to the Peary caribou on the western Queen Elizabeth Islands, the arctic-island caribou on Prince of Wales and Somerset islands were a younger-aged population (average age 4 years, range 1-11 years) with consistently higher productivity (Thomas 1982). Again, the differences between the caribou populations on the islands north and south

of Viscount Melville Sound, Barrow Strait and Lancaster Sound likely reflect relative differences in forage quantity, quality, and availability, and different long-term weather conditions between the two regions (Gunn et al. 1981).

The maximum life-span of Peary caribou is about 15 years (Gunn et al. 1981). The greatest cause of mortality apparently is extreme malnutrition caused by widespread forage unavailability due to unfavourable snow/ice conditions (Parker et al. 1975, Miller et al. 1977a, Gunn et al. 1981). Carcasses of winter-killed caribou with symptoms of malnutrition were found after the 1970-71 and 1977-78 severe winters on Banks Island (Urquhart 1973, Morrison 1978) and on Bathurst Island and eastern Melville Island after the extremely severe winter of 1973-74 (Parker et al. 1975). Adult male caribou, yearlings, and calves were the most vulnerable classes to mortality caused by malnutrition. The rutting activities of adult males deplete their fat deposits before the beginning of winter; thus, their body reserves are often lacking and usually lower than those of females in late winter (e.g., Thomas et al. 1976, 1977, Thomas and Broughton 1978, Thomas 1982).

**F2. Species Movements**

Peary caribou and other arctic-island caribou, like many other cervids, make regular migrations between winter and summer ranges and calving and rutting areas. The unique characteristic of migrations by Peary caribou is that both

inter-island and intra-island movements are involved (Miller et al. 1977b, Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981, Miller 1990a). There are data on two inter-island complexes: one involving the western Queen Elizabeth Islands of Melville-Eglinton-Prince Patrick; and the other Prince of Wales and Somerset islands and the northern Boothia Peninsula. Those inter-island or island-peninsula migrations may have originated through responses to environmental stresses caused by expanding populations or winter forage unavailability, and the migrations are perpetuated by tradition (e.g., Miller et al. 1977a, 1977b, Miller 1990a; see also Vibe 1967 for Greenland caribou movements due to environmental stress).

Sightings of aerially dye-sprayed caribou on Prince Patrick, Eglinton, and Melville islands in June 1974 that had been dye-sprayed on Prince Patrick and Eglinton islands in April 1974 and the observation of caribou on the sea-ice, confirmed inter-island movements of many individuals within that island-complex. Earlier, detected differences in numbers of caribou seen during aerial surveys of those islands (Miller et al. 1977a, 1977b) had led to the belief that Peary caribou were migrating between winter ranges on Prince Patrick and Eglinton islands and summer ranges on Melville Island.

The Inuit of Resolute Bay and Spence Bay had knowledge of the crossing of Peel Sound by arctic-island caribou wintering on Somerset Island and summering on Prince of Wales Island

(Gunn et al 1981). These migrations during May-July were subsequently confirmed and quantified from 1977 to 1980 (Miller and Gunn 1978a, 1979a, 1980, Miller and Kiliaan 1980a, 1981).

Intra-island movements by Peary caribou between winter and summer ranges and to calving or rutting areas are characteristic on many, if not all, islands (e.g., Miller et al. 1977a, Miller 1990a). Caribou on Banks Island move north from wintering ranges on the west coast to the northwest and north coast in May (Urquhart 1973). Peary caribou move to coastal areas on northwestern Melville Island, southeastern Melville (the Dundas Peninsula) and eastern Melville at or shortly after calving (Miller et al. 1977a, Miller 1988). As the thaw advances in the interior during postcalving, the caribou move inland to higher interior plateaus (Miller et al. 1977a, Miller 1989, 1991b). By mid to late August on into September, caribou likely make pre-rut movements back to the coast where the rutting occurs (Miller et al. 1977a; Miller and Barry, in press), based on the relatively high numbers of cast large male antlers on coastal sites.

The cycle of annual movements of Peary caribou is similar to the annual cycle of movements of barren-ground caribou, although there are some different environmental factors involved (Miller 1982). For example, Peary caribou are rarely, if ever, harassed by biting insects which cause some of the mid-summer movements of barren-ground caribou.

The existance of inter- and intra-island movements increase the vulnerability of Peary caribou to disturbance by man's activities (Gunn et al. 1981). As the Peary caribou has such a short season in which to build-up fat reserves, any disturbance of its movements tied to the phenology or the relative availability of the vegetation could have serious consequences. Interruptions and/or disruptions of movements to areas critical during gestation could disrupt or prevent reproduction. Finally, inter-island movements are vitally necessary for restocking islands after declines. Also, although long-term benefits of mixing gene pools within each genotype are difficult to evaluate, such mixing is theoretically beneficial, if not essential, for the well-being of the genome. Continued separation of genotypes (Peary caribou vs. arctic-island caribou) remains paramount, however, from a genetical standpoint in the maintenance and further evaluation of Peary caribou.

**F3. Behaviour/Adaptability**

Peary caribou are usually found in small groups during winter (e.g., Miller et al. 1977a). The groups slightly increase in size prior to calving, stabilize or slightly decrease during calving, then increase into postcalving aggregations as the caribou leave coastal sites and move inland in late July and early August (e.g., Tener 1961, Miller et al. 1977a; Miller 1987a, 1987b, 1988, 1989, 1991b). There was some consistency between mean group sizes of winter and

summer 1972-74 despite the reduction in numbers of caribou, especially in the winter 1973-74 (Miller et al. 1977a). Miller et al. (1977a) suggested that the winter group (mean of 3-5 caribou) is probably a temporarily closed social unit consisting of a family gathering or of sex and/or age related companion animals. Those social units aggregate in July-August to form groupings that averaged 10.1 (2-77) in 1972, 8.6 (2-60) in 1973, and 7.2 (2-33) in 1974 on Melville Island (Miller et al. 1977a). Subsequently, lower densities on Melville Island have led to smaller postcalving groupings of Peary caribou: e.g., mean 5.5 ± 0.27 (S.E.), range 2-20, n = 165, July 1987 (Miller 1988).

The feeding habits of Peary caribou and arctic-island caribou are relatively nonspecialized and they mainly forage on sedges, grasses, willow, forbs, and herbs (Thomas et al. 1976, 1977, Parker 1978, Shank et al. 1978, Thomas and Broughton 1978, Thomas and Edmonds 1983). In contrast to most barren-ground caribou diets, lichens are usually of low proportion in the rumens of Peary and arctic-island caribou, which apparently reflects the low standing crops of lichen (e.g., Russell et al. 1978, Thomas and Edmonds 1983). The volume of mosses in the winter diet (based on rumen contents) is usually high in Peary caribou in poor physical condition (Parker et al. 1975, Thomas et al. 1976, 1977, Thomas and Broughton 1978, Thomas and Edmonds 1983). The high volume of mosses has been related to accidental ingestion because of

high indigestability of mosses (Parker et al. 1975, Thomas and Edmonds 1983), but it is also possible that mosses help to maintain the necessary minimum bulk for effective rumen function (Thomas and Kroeger 1980).

In winter, Peary caribou forage on hilltops, windswept ridges, or raised beaches, which have shallow snow cover or are blown free of snow. Caribou will also use broken rock and boulder fields where snow is deeper but soft or loose and not crusted by the wind. When temperatures in the snow cover climb above 0°C, melt water percolates down through the snow and refreezes at the snow cover-ground surface interface (Miller et al 1982). Wherever the snow cover is 30 cm or more, a significant depth of ground fast ice can accumulate. Such ice layering of several or more centimeters can effectively make much or all of the ground vegetation on such sites unavailable to caribou (Miller et al. 1982). Caribou must respond by leaving rock and boulder fields and other iced areas and move to forage on snow free patches of ground, which is also where plant green-up occurs first (Miller and Gunn 1979a, Miller and Kiliaan 1980b, Miller et al. 1982).

With the loss of the snow cover, caribou feed selectively following the phenology of the vegetation (Gunn et al. 1981). They favour the flowers of Saxifraga oppositifolia, Papaver radicatum, and Pedicularis spp. which are high energy and protein (pre-anthesis flower stage) sources (e.g., Miller et al. 1982, Thomas and Edmonds 1984).

Specific adaptations of Peary caribou to their harsh environment are not detailed except for morphological ones: e.g., their small size and proportions of their appendages; the thick predominantly whitish winter pelage; and their relatively large hooves. Their small groups may be a compromise between social affinities and maintenance of traditions and the sparseness of their forage (Gunn et al. 1981). The virtual absence of bloodsucking and biting insects undoubtedly aids in the deposition of high fat reserves (e.g., the 55 mm of back fat on bulls collected on Prince of Wales Island in August 1978 (D.C. Thomas, unpubl. data). Little is known about their physiology (Gunn et al 1981), though small amounts of lichen in the winter diet solicit interesting questions about urea recycling, water turnover, et cetera, compared with barren-ground caribou, woodland caribou (R. t. caribou) and reindeer (R. t. tarandus).

Little is known about the rut, gestation, parturition, or the mother-young bond in Peary caribou. However, those behaviours along with agonistic and escape behaviours seemingly often parallel those exhibited by barren-ground caribou (Miller 1982).

Whether or not Peary caribou can adapt to human-made changes in their environment remains a critical question (Gunn et al. 1981). Seismic lines were avoided or paralleled by arctic-island caribou on Banks Island (Urquhart 1973). On Prince of Wales Island, caribou cows and calves were more

responsive to helicopter harassment, either overflights or landings nearby, than other sex/age classes (Miller and Gunn 1979b, 1981, 1982, Gunn and Miller 1980, Gunn 1984). Conditions that could lead to habituation of Peary caribou to aircraft, ground vehicles, people or installations remain unknown (Miller and Gunn 1979b).

## G. Limiting Factors

The foremost limitation to Peary caribou is widespread wintertime forage unavailability due to unfavourable snow cover and ice conditions (Gunn et al. 1981). Springtime ground fast ice or even autumn icing can bond the vegetation to the ground: the reduced vertical development of many arctic plants and the absence of thick mats of lichens resulting in even a thin layer of ice prevents foraging. Wind-packed snow, especially snow deeper than 30 cm, prevents cratering or increases the energy required to crater forcing the caribou to move to seek snow-free or shallow snow foraging areas (Miller et al. 1982). Such movements can result in the caribou leaving an island routinely or in a desperate intra-island search for areas to forage in (McEwen 1955, Manning and Macpherson 1958, Urquhart 1973, Miller and Gunn 1978a, 1979a, Miller et al. 1982, Miller 1990a). Mortality from extreme malnutrition, poor recruitment rates, and low productivity are the limitations imposed on the growth of Peary caribou populations by winter snow and ice conditions. Any general warming trend in the climate of the Canadian Arctic Archipelago that leads to more frequent and severe icing (ground fast or layering in the snow cover) and greater total snowfall (especially wet snows in early or late winter) will detrimentally influence the survival of Peary caribou.

The separation of the genotypes strongly suggsts that winter weather is a more stringent limiting factor on Peary

caribou on the Queen Elizabeth Islands than on arctic-island caribou on the mid-arctic islands. The vegetation on the mid-arctic islands is more productive than on the High Arctic Islands (Bliss 1978), but the significance of this to caribou population changes cannot be evaluated in the absence of knowledge of possible relative availabilities of forage between those two regions. Certainly in summer 1961, the Queen Elizabeth Islands held a large caribou population (Tener 1963), but the climatic records support the contention that the decline since 1961 is due mainly to above average severity in winters rather than to the numbers of caribou exceeding the capacity of the ranges (Gunn et al 1981).

The impact of arctic wolf (Canis lupus arctos) predation on Peary caribou is unknown (Gunn et al. 1981). Wolves are not numerous on the western Queen Elizabeth Islands (Miller 1978, Miller and Russell 1978), but they are almost totally dependent on Peary caribou and muskoxen for much of the year. An important consideration involving wolf predation on Peary caribou is the possible indirect influence of muskox and caribou population highs on the same areas being out of synchronization. For example, currently on Melville Island the muskox population is increasing rapidly in size while the Peary caribou population continues its long-term decline (Miller 1988). The wolves on Melville Island will likely increase in number in response to the greater numbers of muskoxen. Therefore, even only incidental predation by wolves

on the Peary caribou on Melville Island could become significant on a proportionate basis. This condition would be particularly important, if selective predation on newborn caribou also routinely occurs as wolf numbers increase (cf. Miller et al. 1985). Thus, the relative importance of wolf predation on Peary caribou likely varies greatly over time and space and cannot be totally dismissed as it is most likely at least an intermittent serious cause of mortality.

Many Inuit believe that competition occurs between muskoxen and Peary caribou or arctic-island caribou and that it often leads to drastic reductions in the numbers of exposed caribou. To date, however, investigations of this supposed muskox-caribou competition have yielded no proof that competition for space or forage exists: Kevan (1974), Wilkinson et al. (1976), Parker and Ross (1976), Miller et al. (1977a), Parker (1978), Vincent and Gunn (1981) and Thomas and Edmonds (1984). If such competition ever does occur at any level, it most likely would occur during wintertime or springtime periods of widespread forage unavailability brought on by unfavourable snow cover or icing conditions (Miller et al. 1977a). Such conditions were observed on Bathurst Island in late winter 1973-74 (Miller et al. 1977a) but no competition between the muskoxen and caribou was discerned.

Evidence of debilitating diseases was not found in Peary caribou or other arctic-island caribou necropsied by Parker et al. (1975), Thomas et al. (1976, 1977), and Thomas and

Broughton (1978). Those authors also reported a low but variable incidence of warble fly (Oedemagena tarandi L.) larvae between and among islands and years.

Peary caribou are traditionally hunted in early and late winter, though use of snowmobiles has tended to lengthen the Inuit's hunting season (e.g., Bissett 1968, Riewe 1973). Changes in the Inuit hunting patterns have resulted from the shift to a wage earning economy (Riewe 1978). Inuit can now often improve their hunting effectiveness by purchasing better equipment and more supplies. This has probably more recently increased the pressure on arctic-island caribou, as it already has done in the 1960s on Peary caribou on southern Ellesmere Island (Riewe 1973).

As noted by Gunn et al. (1981), Inuit of Grise Fiord annually took an average of 26 Peary caribou in the Jones Sound region but "even this miniscule harvest has had deleterious effects upon the caribou population" (Riewe 1973:21) and, "By 1968 the caribou were virtually eliminated" within 60 km of Grise Fiord. The southern Ellesmere population of caribou might already have been in a state of decline due to climatic changes (Vibe 1967, Riewe 1973), but there is little doubt that hunting was an additional decimator of the caribou that accelerated or even determined the decline. More recently the annual harvest of Peary caribou by Grise Fiord Inuit has dropped from about 50 in the early 1980s to 25 in 1986 and 1987 (M.A.D. Ferguson, pers. commun.,

1989). On the other Queen Elizabeth Islands, there was some industry-supported hunting out of Rea Point on eastern Melville Island during the 1970s (Gunn et al. 1981). Caribou hunting on Bathurst Island was voluntarily stopped by the Resolute Bay Inuit hunters in 1975, when the caribou numbers became dangerously low (Freeman 1975). Since 1975, most, and since 1982, essentially all, of the caribou killed by Resolute Bay hunters come from Somerset, Prince of Wales and Russell islands. In the late 1980s and early 1990s some of those harvested caribou were sold to the Grise Fiord Inuit.

Caribou meat is highly valued by the Inuit and little is wasted (Usher 1970, Riewe 1978). Although hunting techniques have changed (as have storage facilities) and the duration of the annual caribou hunting period has extended (Bissett 1968, Usher 1970, Riewe 1973, 1978), there is no general acceptance within the Inuit communities that hunting has the potential for becoming one, or especially the major, limiting factor for caribou (Gunn et al. 1981).

Severe limitations imposed by climate on populations of arctic-island caribou, especially Peary caribou on the High Arctic Islands, can magnify other factors affecting population levels and increase the possiblilty of these becoming greater limiting factors (Fig. 3). In particular, the effects of even apparently low levels of incidental wolf predation or intensive harassment by aircraft, ground vehicles, or ground installations could have an insidious effect on Peary caribou,

which in time, could be a limiting factor (e.g., Miller and Gunn 1979b, Gunn 1984). Interruption of foraging patterns during the short summer could reduce the fat reserves needed for successful reproduction, and similarly, any increased energy expenditure as a response of harassment could have long-term effects on reproduction, as well as survival (Fig. 3). The importance of traditional areas and seasonal ranges to the survival of Peary caribou has been previously noted (Gunn et al. 1981). In the absence of data to the contrary, it was suggested that any harassment reducing or preventing free movements among those areas, would act as a limiting factor on subsequent population growth and survival.

The effects of harvest, predation, and harassment have to be considered in light of the low recruitment, which is apparently characteristic of the Peary caribou, and the often high mortality (Gunn et al. 1981). In such a situation, where the caribou populations are so strongly controlled by climate, any additional factors can tilt the balance to the detriment of the caribou populations.

## H. Special Significance Of The Species

The Peary caribou is a unique, socially important, and economically valuable part of Canada's natural heritage. The Peary caribou is now regularly not found anywhere in the world outside of the Canadian High Arctic; thus, the responsibility for its preservation is totally Canadian.

The Peary caribou has the most restricted distribution in terms of usuable range of the North American caribou, as they occur regularly only on the High Arctic Islands of Canada. The arctic-island caribou have only a slightly larger usable range (but generally of better quality), occurring on the mid-arctic islands in the southern tier of the Canadian Arctic Archipelago and on the Boothia Peninsula of the mainland Northwest Territories. Unfortunately, the arctic-island caribou have never received the special recognition that they deserve as a discrete form of Rangifer. Remoteness and isolation of the Peary caribou's range is generally reflected in our lack of knowledge about the subspecies (Jakimchuk 1975). Although Peary caribou were known and utilized by early explorers of the High Arctic Islands (e.g., Miller et al. 1977a), they were not recognized as a distinct form until Allen (1908) described them from specimens collected by R.E. Peary on Ellesmere Island. The current taxonomic status of Peary caribou is as a subspecies (Banfield 1961). Interbreeding with R. t. groenlandicus may have contributed to the differentiation of the arctic-island caribou that occur on

all of the southern tier of islands in the archipelago (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed et al. 1986). The most characteristic and genetically purest stock of pearyi now occurs only on the Queen Elizabeth Islands.

R. t. pearyi is distinguished from other subspecies by its small size, short and blunt but proportionately large hooves and a short pointed muzzle. One of the most characteristic features is the silky, long, predominantly whitish winter coat. The antlers have pale gray velvet in summer, and the pelage is slate-coloured above with white legs and undersides in summer (Manning 1960, Banfield 1961).

The Peary caribou was possibly an important source of food for the early natives on Ellesmere and other islands (Rieve 1973), and is still highly preferred meat by Inuit in the High Arctic. The early explorers to the Arctic Islands also eagerly hunted Peary and arctic-island caribou for fresh meat.

The population dynamics of Peary caribou apparently have been dominated by the recent climate, especially the stresses of wintertime conditions which strongly influence rates of reproduction, recruitment and adult survival (Gunn et al. 1981). The inter-island movements are a particularly significant adaptation to sparse ranges, unfavourable snow and ice conditions, and the recolonization of islands after severe winters which periodically or sporadically depopulated the

caribou (Miller 1990a). There are likely few large mammal populations which show such marked highs and lows in their numbers almost entirely due to weather affecting forage availability. However, the importance of wolf predation alone or in combination with unfavourable weather conditions during population highs, and especially during population lows, is unknown.

As noted by Gunn et al. (1981), the Peary caribou is an important prey item for the high arctic wolf and carrion for scavengers such as arctic foxes (Alopex lagopus), gulls (Larus spp.), and jaegers (Stercorarius spp.). Also, the Peary caribou is not only a source of meat for the Inuit, but it is a symbol of their cultural relationships with their environment. The adaptations and adaptability of Peary caribou make it a particularly intriguing form of Rangifer to biologists, and thus as an integral part of Canada's arctic ecosystem - the conservation of Peary caribou should be a matter of broad concern.

The Peary caribou of the Canadian High Arctic Islands is the only member of the entire deer family, Cervidae, that has been able to establish itself and persist there under present-day climatic conditions. However, the current overall number of Peary caribou on those islands is dangerously low, a mere remnant of their former numbers. Thus, existing populations of Peary caribou are essentially unharvestable on a sustained yield basis.

Therefore, to reiterate, the Peary caribou warrants recognition as an Endangered form of wildlife in Canada because (1) the total number of the genetically purest form is critically low (3300-3600); (2) it is the sole representative of the deer family, Cervidae, and of the caribou/ reindeer genus Rangifer found in the Canadian High Arctic; (3) it is a unique part of Canada's natural heritage, as it now occurs regularly, on a worldwide basis, only on the Queen Elizabeth Islands of the Canadian High Arctic; (4) it is economically valuable, both as a staple nourishment and for future tourism; (5) it is culturally important to the High Arctic Inuit, as a symbol of traditional ties to their environment; and (6) anthropogenic climate change ("The Greenhouse Effect"), greatly increased exploration for the development of nonrenewable resource activities, and increased hunting pressure all have the potential for impacting detrimentally on the populations of Peary caribou on the Canadian High Arctic.

## I. Recommendations/Management Options

In summary, the Peary caribou numbers on the Queen Elizabeth Islands are less than 10% of their former (1961) strength (except on the eastern islands of Ellesmere, Devon and Axel Heiberg where their numbers were never high). This low comes at a time when human-induced pressures could markedly increase. The seriousness of their low numbers is apparent from a projection of population increases possible in a favourable environment on southwestern and south-central Queen Elizabeth Islands (Table 5). The likelihood that favourable conditions would allow prolonged rapid increases in numbers of Peary caribou in the near future is, at best, most doubtful based on 26 years (1961-87) of information on population dynamics and the current low number of Peary caribou. Thus, several decades must pass before significant recovery of Peary caribou could occur in the Canadian High Arctic (Table 5). In the interim, the Inuit of the High Arctic need the moral support that will come from the realization that other Canadians recognize the potential dangers to Peary caribou caused by a changing world. Thus, recognition of the precarious and currently endangered existence of Peary caribou with toleration of the high arctic Inuit's cultural and economic needs for at least limited harvesting of the resource would be a great stride forward in initiating the preservation of Peary caribou.

Exploration and exploitation of petroleum and mineral

resources increased steadily throughout the 1970s in the Canadian Arctic. Then, a temporary lull set in as the demand on the world markets for crude oil and metals weakened and third-world countries cut prices. It is only a matter of time, however, before world markets improve and higher prices stimulate renewed vigour in nonrenewable resource exploitation in the Canadian Arctic. All-year ice-breakers and barges could represent a potentially serious effect on inter-island movements to escape environmental stresses and seasonal migrations to maximize the use of the best ranges available. Almost all developments will be accompanied by increases in aircraft traffic and ground installations. In addition, the employment of Inuit can indirectly increase hunting pressures because of increased cash to purchase hunting equipment and supplies. These changes, on a large-scale, have the potential for seriously impacting on Peary caribou (Fig. 3).

The following points should be considered when evaluating the status of Peary caribou. (1) The Peary caribou is culturally important and economically valuable (utilization and tourism) to the high arctic Inuit. (2) The overall number of Peary caribou is dangerously low, at an estimated 3300-3600. (3) Human activities could potentially further the observed long-term decline, keeping the number of Peary caribou at an unusable level. (4) None of the populations of Peary caribou is currently capable of sustaining any appreciable level of annual harvest. (5) No other form of

Rangifer (even the arctic-island caribou) could successfully replace the Peary caribou (R. t. pearyi) in the demanding setting of the Queen Elizabeth Islands without significant climatic change or first evolving over time the necessary adaptations of pearyi. (6) The overall range of the true Peary caribou (R. t. pearyi) is now restricted to the Queen Elizabeth Islands of the Canadian Arctic Archipelago, a small fraction of its former extent, as viable populations of R. t. pearyi currently do not exist in Greenland and R. t. pearyi has been replaced on the southern tier of islands in the Canadian Arctic Archipelago by a genotypically and phenotypically different form of arctic-island Rangifer. Thus, the true Peary caribou (R. t. pearyi) is a genetically unique form of Rangifer that is now found only in Canada and is currently endangered by its extremely low number. Therefore, the Peary caribou is now a unique part of Canada's arctic natural heritage and the preservation/conservation of the Peary caribou is firstly the responsibility of Canadians.

The following recommendations are made on the basis of this updated report.

1. Peary caribou (Rangifer tarandus pearyi) now found on the Queen Elizabeth Islands of the Canadian Arctic Archipelago should be classified as "Endangered", because of their 3-decade, apparently continual decline in overall number and their current dangerously low overall number.

2. The caribou population on Banks Island should be classified as "Endangered", as the reported annual harvest exceeds any sustainable level for the currently estimated size of the population.

3. All caribou found on the remainder of the southern tier of Arctic Islands (excluding Baffin and Bylot islands) and arctic-island caribou that have seasonal ranges on the Boothia Peninsula north of its isthmus (north of 70°N) should be classified as "Threatened".

## J. Evaluation

Degerbøl (1957:47, 54) and Banfield (1961:65) concluded from their investigations that Peary caribou (R. t. pearyi) and the now extinct East Greenland reindeer (R. t. eogroenlandicus) were closely related. More recently Willemsen (1983) and Hakala et al. (1985) have remarked on the similarity among pearyi, eogroenlandicus, and the Svalbard reindeer (R. t. platyrhynchus), thus indicating a close taxonomic affinity among all three forms of circumpolar arctic island caribou. Further support for this relationship has been put forth by Røed et al. (1986) with the finding that one of only two alleles that coded for transferrin in the Svalbard reindeer is held in common with pearyi (neither has been found in continental reindeer).

Thus, after the end of the last Ice Age, surviving primitive Peary caribou radiated out from their refugium or refugia and colonized or recolonized the entire Canadian Arctic Archipelago (apparently except Baffin and Bylot islands) and, likely, areas of Greenland and Spitzbergen. During at least the last dispersal of caribou in the Canadian Arctic Archipelago, the southern tier of islands was occupied to varying degrees possibly by both the subspecific pearyi form and the groenlandicus form.

The barren-ground caribou may have intergraded with the resident Peary caribou and became the dominant southern island forms (pearyi > groenlandicus and groenlandicus > pearyi).

For unknown reasons, the barren-ground caribou was only successful in colonizing the extreme eastern portion of the Archipelago (Baffin and Bylot) on a year-round basis at the exclusion of Peary caribou. Elsewhere on the southern islands the barren-ground caribou is known only to be successful as a summer migrant. Year-round occupation of the southern islands favoured the merging of pearyi and groenlandicus features - thus, apparently creating a better adapted intergrade whose current taxonomic designation as "Peary caribou" is misleading in terms of its preservation and conservation.

Peary caribou on the Queen Elizabeth Islands exhibit the most developed and genetically diverse characteristics of the pearyi form (Manning 1960, Banfield 1961, Thomas and Everson 1982, Røed et al. 1986). Thus, the stage is set only on the Queen Elizabeth Islands of the Canadian High Arctic for the further evolution of the pearyi form through physiological and behavioural adaptations to their more demanding and less rewarding environment.

Since 1961, Peary caribou on the Queen Elizabeth Islands have declined by about 92% on the islands, where 94% of the 25 845 Peary caribou were estimated in 1961. Since 1972, arctic-island caribou on Banks Island have declined in number by about 70% and current rates of annual harvest exceed any sustainable level for the population. On Victoria Island, the true current numerical status of arctic-island caribou is unknown within meaningful management limits, as evidenced by

the biologically impossible disparities between existing population estimates and their reported associated rates of annual harvests. Elsewhere on the southern tier of Arctic Islands, the current numerical status of populations of arctic-island caribou are unknown because of the lack of updated population estimates. Documentation of the genetic variation between arctic-island caribou (R. t. groenlandicus x pearyi) on the southern tier of Arctic Islands and the purest line of pearyi the Peary caribou on the Queen Elizabeth Islands continues (Røed et al. 1986, Røed and Whitten 1986; K.H. Røed, pers. commun., 1989, Røed 1991). Although the taxonomic position of the "arctic-island" caribou appears transitional to groenlandicus and pearyi, it should, for the purpose of its preservation and conservation, be treated as a unique form of Rangifer and different from pearyi of the Queen Elizabeth Islands. Maintenance of populations of "arctic-island" caribou that can sustain relatively high levels of annual harvest is also critical to the conservation of Peary caribou on the Queen Elizabeth Islands. If high arctic Inuit could not hunt caribou on the southern tier of Arctic Islands, they would have to turn to the already depleted populations of Peary caribou on the Queen Elizabeth Islands for much of their annual diet of fresh red meat. The monetary benefits of hunting caribou are very real and the need for hunting caribou is culturally strong: 100 kg of preferred caribou meat is currently worth about $2,000 at Resolute Bay prices for much

less desirable store bought beef. Significant and sometimes catastrophic climate-caused fluctuations in numbers of Peary caribou on the High Arctic Islands are known. Possibly less disastrous, but apparently significant, losses of other "arctic-island" caribou due to unfavorable weather conditions leading to widespread forage unavailability have also been suggested for the mid-arctic islands of the Canadian Arctic Archipelago. The role of humans in these weather related events is unknown but the possible influence of human-induced actions in indirectly aggravating or producing these events cannot be ruled out at this time.

Against the all-pervading influence of the severe climate on Peary caribou, the potential effects of anthropogenic climate change, increased hunting, and rapidly increasing industrial activity could menace the future of Peary caribou.

Recognition of the "Endangered" state of Peary caribou in the Canadian High Arctic would stengthen the likelihood for conservation of Peary caribou by fostering the will for self-restraint among the high arctic Inuit. Such recognition would also greatly assist in future efforts for the preservation of Peary caribou in the eventual face of inevitable nonrenewable resource development in the Canadian Arctic.

It is recommended that the following specific guidelines for various levels of classification based on 1+ yr-old Peary caribou only (Table 6) be used for setting upper limits of classification for Peary caribou populations on the Queen

Elizabeth Islands. It is recommended that Peary caribou on the Queen Elizabeth Islands be recognized as "Endangered" as long as the number of 1+ yr-old Peary caribou on the entire Queen Elizabeth Islands remains below 6000 individuals.

## K. Acknowledgements

This Peary caribou status report is an update of the first and second status reports on Peary caribou by the Canadian Wildlife Service to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)(Gunn, A.; Miller, F.L.; and Thomas, D.C. 1979; Miller 1990b). I freely acknowledge the contributions made by my coauthors in the first Peary caribou status report. When statements from the original texts remain currently accurate and pertinent, they have been incorporated either essentially as previously stated or revised to conform with my current thinking on the subject. Thus, I am solely responsible for any resultant errors of omission or commission. Also, I am solely responsible for the position taken and the conclusions drawn in this report. This report is intended only as an updated working document for use by COSEWIC in their evaluation of the current status of Peary caribou.

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Table 1
Numbers of Peary caribou on the 10 Queen Elizabeth Islands for which 26-year trends are available, Canadian High Arctic, 1961-1987

| Island | Size of Island ($km^{-2}$) | Estimated Number | | | |
|---|---|---|---|---|---|
| | | 1961[a] | 1973[b] | 1974[b] | 1985-87[c] |
| Melville | 42 220 | 12 799 | 3422 | 1679 | 943 |
| Bathurst | 16 090 | 2723 | 712 | 231 | 495 |
| Prince Patrick | 15 830 | 2254 | 807 | 621 | 154 |
| Eglinton | 1550 | 204 | 12 | 18 | 79 |
| Lougheed | 1300 | 1325 | 66 | 0 | 0 |
| Vanier | 1130 | 396 | 24 | 10 | 67 |
| Cameron | 1060 | 235 | 9 | 12 | 51 |
| Emerald | 550 | 161 | 39 | 20 | 14 |
| Alexander | 490 | 198 | 0 | 0 | 38 |
| Massey | 440 | 13 | 52 | 0 | 76 |
| All 10 Islands | 80 660[d] | 20 308* | 5143 | 2591 | 1917 |
| % decrease from 1961 | | | 74.7 | 87.2 | 90.6 |

[a] From Tener (1963).
[b] From Miller et al. (1977a).
[c] From Miller (1987a, 1987b, 1988).
[d] Equals 19.4% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 $km^2$ each in size.
* Equals 78.6% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

Table 2
Numbers of Peary caribou on the five Queen Elizabeth Islands for which 13-year trends are available, Canadian High Arctic, 1961-1974

| Island | Size of Island ($km^2$) | Estimated Number | | | |
|---|---|---|---|---|---|
| | | 1961[a] | 1973[b] | 1974[b] | 1985-87[c] |
| Mackenzie King | 5050 | 2192 | 0 | 36 | (27) |
| Bordon | 2800 | 1630 | 19 | 10 | (7) |
| Byam Martin[d] | 1160 | - | 43 | 6 | 98 |
| Brock | 760 | 190 | 28 | 14 | (10) |
| Little Cornwallis | 410 | 0 | 0 | 9 | (7) |
| All 5 Islands | 10 180[e] | 4012[f] | 90 | 75 | 149 |
| % decrease from 1961 | | | 97.8 | 98.1 | (96.3) |

[a] From Tener (1961).
[b] From Miller et al. (1977a).
[c] Extrapolcated values (in parentheses) were obtained by assuming percentage loss between 1985-87 and 1974 in Table 1 (26.0%) is applicable to these four islands during the same time period.
[d] Trend for Byam Martin is based on 14 years (1973-1987).
[e] Equals only ca. 2.5% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 $km^2$ in size.
[f] Equals 15.5% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).

Table 3
Numbers of Peary caribou on the 11 Queen Elizabeth Islands for which only one or no estimate exists, Canadian High Arctic

| Island | Size of Island ($km^2$) | Estimated number 1961[a] | Indirectly extrapolated number 1985-87[b] |
|---|---|---|---|
| Ellesmere | 196 240 | 200 | |
| Devon | 55 250 | 150 | |
| Axel Heiberg | 43 180 | 300 | |
| Ellef Ringnes | 11 300 | 114 | |
| Cornwallis | 7000 | 43 | |
| Subtotal | 312 970[c] | 807[d] | (807)[e] |
| Amund Rignes | 5260 | 452 | |
| Cornwall | 2260 | 266 | |
| Subtotal | 7520[f] | 718[g] | (531)[h] |
| Graham | 1380 | - | |
| Meighen | 960 | - | |
| King Christian | 650 | - | |
| North Kent | 590 | - | |
| Subtotal | 3580[j] | - | - |
| Total (all 11 islands) | 324 070[k] | 1525[m] | (1338)[n] |

Continued

Table 3 Continued

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[a] From Tener (1963).
[b] See footnotes e, h and n.
[c] Equals 75.4% of the entire landmass of all 26 Queen Elizabeth Islands that are greater than 400 km² each in size.
[d] Equals only 3.1% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).
[e] Empirical and hearsay evidence suggests that Tener's (1963) 1961 estimates for these five islands were low; so they likely remain approximately equal in 1985-87.
[f] Equals only 1.8% of the entire landmass under consideration.
[g] Equals only 2.8% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).
[h] Obtained by assuming percentage loss from 1961 was equal to the loss that occurred between 1985-87 and 1974 in Table 1 (26.0%).
[j] Equals only 0.9% of the entire landmass under consideration.
[k] Equals 78.1% of the entire landmass under consideration.
[m] Equals only 5.9% of the 25 845 Peary caribou estimated on the Queen Elizabeth Islands in summer 1961 (Tener 1963).
[n] This extrapolated value suggests a 12.3% reduction in the number of Peary caribou within this complex of 11 islands from 1961 to 1985-87.

Table 4
Numbers of arctic-island caribou (possible intergrades of *pearyi* and *groenlandicus*) on the southern tier of islands (south of 74°N) in the Canadian Arctic Archipelago and on the Boothia Peninsula (north of 71°10′N), Northwest Territories

| Year Estimate Obtained | Estimate | % Decrease From Initial Estimate | Time Lapse In Years | Source |
|---|---|---|---|---|
| Victoria (217 290 km²) and Stefansson (4460 km²) equals 221 750 km² 60.6% of the entire landmass | | | | |
| 1980 | 7936 | - | - | Jakimchuk & Carruthers (1983) |
| Banks (70 030 km²), 19.1% of the entire landmass | | | | |
| 1972 | 12 098 | - | - | |
| 1979-80[a] | 7820 | 35 | 7-8 | Urquhart (1973) |
| 1982 | 10 046 | 17 | 10 | Vincent (1979, 1980) |
| 1985 | 5903 | 51 | 13 | Latour (1985)[b] |
| 1987 | 5799 | 52 | 15 | McLean *et al.* 1986[c] |
| 1989 | 3490 | 71 | 17 | B. McLean (pers. commun.)[d] |
| 1991 | 939 | 92 | 19 | McLean and Fraser (1991)[e] |
| Prince of Wales (33 340 km²), Somerset (24 790 km²), Russell (940 km²), and Prescott (410 km²) equals 59 480 km², 16.3% of the entire landmass, plus Boothia Peninsula[g] (ca. 26 000 km²) | | | | Fraser et al. (1991)[f] |
| 1974 | 6308 | - | - | Fischer and Duncan (1976) |
| 1975 | 6569 | (+4) | 1 | Fischer and Duncan (1976) |

Continued

Table 4 Continued

| Year Estimate Obtained | Estimate | % Decrease From Initial Estimate | Time Lapse In Years | Source |
|---|---|---|---|---|
| 1980 | 5772 | 8-12 | 6 | Gunn and Miller (1983)[h] |
| King William (13 110 km²), Royal Geographical Society Islands (610 km²), Matty, (480 km²) and Jenny Lind (420 km²) equals 14 620 km², 4.0% of the entire landmass | | | | |
| 1986 (only 4 caribou seen on Survey of King William Island) | | - | - | A. Gunn (pers. commun., 1989) |

[a] Only southern half of Banks Island was surveyed in 1979 and northern half in 1980 (Vincent 1979, 1980).
[b] Estimate of 7233 1+ yr-old caribou divided by 0.72 to include 28% calves, (Latour 1982, 1985) so that 1982 estimate would be in agreement with earlier ones that included calves in the estimate.
[c] Estimate of 5000 1+ yr-old caribou divided by 0.847 to include 15.3% calves (McLean et al. 1986) so that 1985 estimate would be in agreement with earlier ones that included calves in the estimate.
[d] Estimate of 4500 1+ yr-old caribou divided by 0.776 to include 22.4% calves (McLean and Fraser 1991) so that 1987 estimate would be in agreement with earlier ones that included calves in the estimate.
[e] Estimate of 2600 1+ yr-old caribou divided by 0.745 to include 25.5% calves (McLean and Fraser 1991) so that the 1989 estimate would be in agreement with earlier ones that imcluded calves in the estimate.
[f] Estimate of 888 1+ yr-old caribou divided by 0.956 to include 5.4% calves (Fraser et al. 1991) so that the 1991 estimate would be in agreement with earlier ones that included calves in the estimate.

Continued

Table 4 Continued

[a] Entire Boothia Pen. north of 71°10'N was aerially surveyed only in 1985: tentative estimate is 4000-5000 (A. Gunn, pers. commun., 1989).

[b] Estimate of 5022 1+ yr-old caribou divided by 0.87 to include 13% calves; (Gunn and Miller 1983) so that 1980 estimate would be in agreement with earlier ones that included calves in the estimate.

Table 5
Extrapolations of Peary caribou populations on two island-complexes of the Queen Elizabeth Islands from the most recent estimated levels to usable and theoretical maximum densities that could be expected under satisfactory range and environmental conditions

| At mean density[a] of caribou per 100 km$^{-2}$ | Size of complex (km$^2$) | Expected number of caribou at given density | Approximate number of years[b] of continual population growth required to achieve mean densities at net annual increases of | | | | |
|---|---|---|---|---|---|---|---|
| | | | 25% | 20% | 15% | 10% | 5% |
| Southwestern (1986-87 est. 1288) | | | | | | | |
| 5 | 61 310 | 3066 | 4 | 5 | 7 | 10 | 18 |
| 10 | | 6131 | 7 | 9 | 12 | 17 | 32 |
| 15 | | 9197 | 9 | 11 | 15 | 21 | 41 |
| 20 | | 12 262 | 11 | 13 | 17 | 24 | 47 |
| South-central (1985-87 est. 779) | | | | | | | |
| 5 | 26 620 | 1331 | 3 | 3 | 4 | 6 | 11 |
| 10 | | 2662 | 6 | 7 | 9 | 13 | 26 |
| 15 | | 3993 | 8 | 9 | 12 | 18 | 34 |
| 20 | | 5324 | 9 | 11 | 14 | 21 | 40 |

[a] The assumption is that these populations of Peary caribou would become borderline usable at 5 caribou · 100 km$^{-2}$; have reached an ideal stocking level at 15 caribou · 100 km$^{-2}$; and would be reaching a maximum level at 20 caribou · 100 km$^{-2}$ beyond which the capacity of their range to support them on a year-round basis would be taxed over the long term.

Continued

Table 5 Contined

[b] Always estrapolated to exceed "expected number of caribou at a given density"; therefore, accuracy sometimes is ± 1 year.

Table 6
Recommended upper limits of Peary caribou populations (based on 1+ yr-old caribou only) to serve as guidelines for various levels of preservation/conservation of Peary caribou on the Queen Elizabeth Islands, Canadian High Arctic

| Queen Elizabeth Islands involved by island-complex | Upper limits of Peary caribou populations by preservation/conservation categories | | | |
|---|---|---|---|---|
| | Endangered (<) | Threatened (<) | Vulnerable (<) | Rare (<) |
| Southwestern QEI | 3000[a] | 6000 | 9000 | 12 000 |
| Melville, Prince Patrick, Eglinton, Byam Martin and Emerald | (5.0)[b] | (10.0) | (15.0) | (20.0) |
| South-central QEI | 1300 | 2700 | 4000 | 5500 |
| Bathurst, Cornwallis, Vanier, Cameron, Alexander, Massey and Little Cornwallis | (5.0) | (10.0) | (15.0) | (20.0) |
| Northwestern QEI | 100 | 200 | 300 | 500 |
| Ellef Ringnes, Amund Ringnes, Cornwall, Graham, Lougheed, Meighen, King Christian and North Kent | (1.0) | (2.0) | (3.0) | (4.0) |
| North-central QEI | 200 | 500 | 700 | 1000 |
| Ellef Ringnes, Amund Ringnes, Cornwall, Graham, Lougheed, Meighen, King Christian and North Kent | (1.0) | (2.0) | (3.0) | (4.0) |

Continued

Table 6 Continued

| Queen Elizabeth Islands involved by island-complex | Upper limits of Peary caribou populations by preservation/conservation categories | | | |
|---|---|---|---|---|
| | Endangered (<) | Threatened (<) | Vulnerable (<) | Rare (<) |
| <u>Eastern QEI</u> | | | | |
| Ellesmere, Devon, and Axel Heiberg | 1400 (0.5) | 2600 (1.0) | 4000 (1.5) | 6000 (2.0) |
| Entire 26 QEI listed above | 6000 (1.5) | 12 000 (3.0) | 18 000 (4.5%) | 25 000 (6.0) |
| Overall mean density per 100 $km^{-2}$ | | | | |

[a] These values are read as follows, e.g., Southwestern QEI: Endangered = less than 3100; Threatened = less than 6100; Rare = less than 9200; and greater than 12 300 Peary caribou 1+ yr-old would result in delisting.

[b] Approximate mean density of 1+ yr-old Peary caribou per 100 $km^{-2}$ within that island-complex at the upper limit of the given level (category) of preservation/conservation.

Fig. 1. Current range of the Peary caribou (Rangifer tarandus pearyi), Queen Elizabeth Islands, Canadian Arctic Archipelago

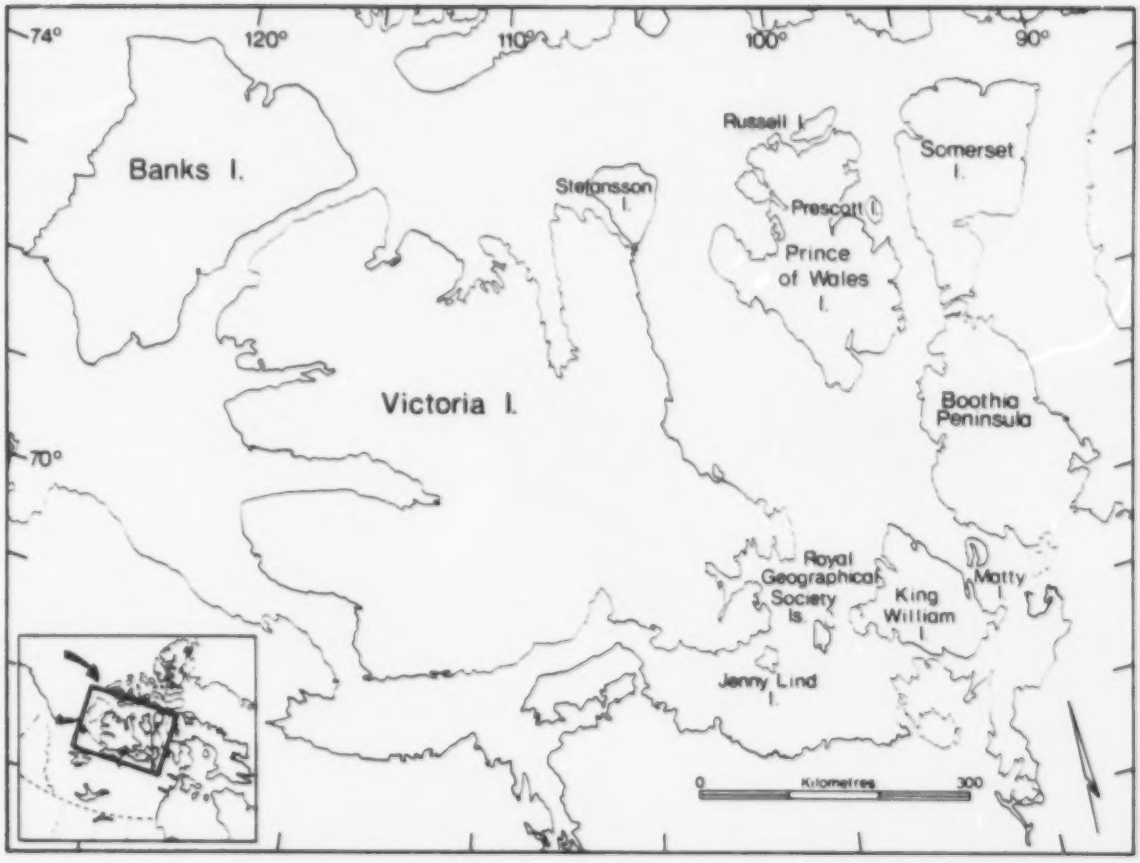


Fig. 2. Current range of arctic-island caribou (Rangifer tarandus groenlandicus x pearyi), southern tier of islands (south of 74° N: excluding Baffin and Bylot islands) and the Boothia Peninsula north of its isthmus, NWT

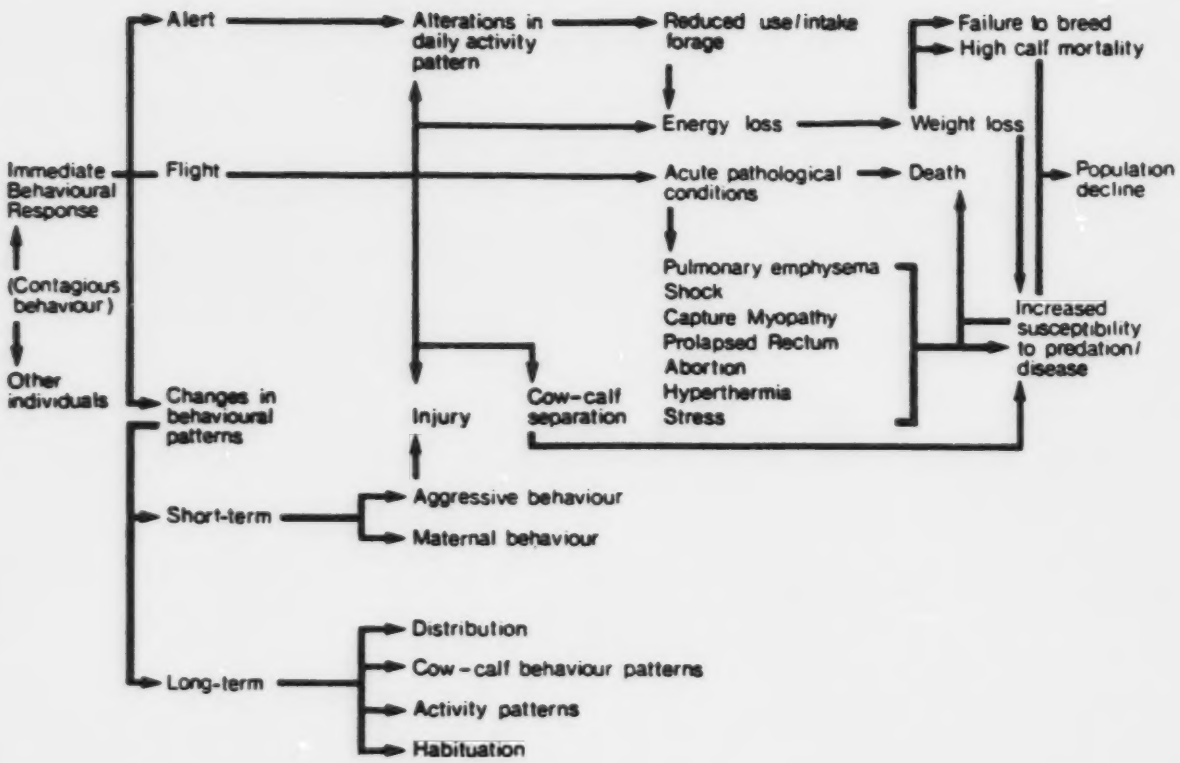


Fig. 3. Schema of some potential effects of harassment and their interrelationships for Peary caribou (from Miller and Gunn 1979b).